Industrial QUALITY CONTROL

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—H. F. DODGE

Application of Quality Control in the Manufacture of Electrical Cable
—C. KENNETH HAMLIN

Some Notes on the Theory and Application of Rank Order Statistics, Part I
—RALPH ALLAN BRADLEY

QUALITY
through
Scientific Methods

Journal of the
AMERICAN SOCIETY FOR QUALITY CONTROL

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Industrial Quality Control

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Skip-Lot Sampling Plan*

H. F. DODGE

Bell Telephone Laboratories, Inc.

This article presents a skip-lot sampling plan that is applicable to bulk materials or products produced or furnished in successive batches or lots. The plan will be described in terms of a particular application that has been found useful, namely, for chemical laboratory tests made in the receiving or acceptance inspection of raw materials purchased regularly from a common source. The plan is also applicable to in-process and final inspections, and generally to any inspection or test program which normally calls for periodic checking of a continuing output or checking of each of a succession of consecutive batches of material. For convenience, this general plan will be designated as SkSP-1 (skip-lot sampling plan).

Applied to chemical and physical analyses, sampling plan SkSP-1 provides a basis for reducing testing costs. Substantial savings can be expected in such application to receiving inspection of products which normally conform to specification and for which laboratory tests are required on each lot.

The plan constitutes an application† of the principles of a published continuous sampling plan‡ which will be designated here as CSP-1. It may help to outline here briefly the essential features of this plan. Plan CSP-1 applies to the inspection of a flow of individual product units, made available for inspection consecutively in the order of their production, as for example, on a conveyor line of a continuous process. The procedure for CSP-1 is as follows:

a. At the outset, inspect 100 percent of the units consecutively as produced and continue such inspection until i units in succession are found clear of defects.

b. When i units in succession are found clear of defects, discontinue 100 percent inspection, and inspect only a fraction f of the units, selecting individual sample units one at a time from the flow of product, in such a manner as to assure an unbiased sample.

c. If a sample unit is found defective, revert immediately to a 100-percent inspection of succeeding units and continue until again i units in succession are found clear of defects, as in paragraph (a).

d. Correct or replace with good units, all defective units found.

The protection offered by this plan is determined by values of the constants of the plan, f and i. For given values of f and i, there will result for a given level of incoming quality (incoming fraction defective, p), a definite expected or average outgoing fraction defective (average outgoing quality, AOQ). For any given values of f and i, the AOQ will have a maximum for some particular fraction defective, p_1, of incoming quality. This maximum is referred to as the "average outgoing quality limit (AOQL)." For all other values of incoming fraction defective p, greater or less than p_1, the AOQ will be less than the AOQL. Thus the protection of the plan is expressed in terms of AOQL, in fraction defective, or percent defective.

These thoughts are carried over into plan SkSP-1 but some of the terms take on a different meaning. Instead of a series of product units as in CSP-1, we now consider a series of lots. When plan SkSP-1 is applied to laboratory analysis tests of raw materials, the relationship of some of the terms may be seen from the comparisons in Table I.

The thing to note in particular is the changed meaning of the term AOQL. If, for a given test characteristic, we pick an SkSP-1 plan with a 2% AOQL and follow the rules of the game as set out below, we can feel confident that in the long run not more than two percent of the accepted lots will be nonconforming with respect to that characteristic. Thus the plan is a corrective one—it provides an upper bound to the "average percentage of accepted lots that will be nonconforming."

*Presented on the program of the Annual Middle Atlantic Regional Conference, Baltimore, Md., Feb. 5, 1954.

†This type of application was first brought to the author's attention by Dr. J. H. Davidson of the General Electric Company.

‡H. F. Dodge, "A Sampling Plan for Continuous Production," *Annals of Mathematical Statistics*, V. 14, No. 3, pp. 264-279, Sept. 1943; and *Transactions of the American Society of Mechanical Engineers*, V. 66, No. 2, pp. 127-133, Feb. 1944.

APPLICATION TO PURCHASED RAW MATERIALS

The following paragraphs give a suggested procedure for applying skip-lot sampling plan SkSP-1 to the acceptance testing of raw materials, with special reference to chemical and physical characteristics that require laboratory analyses or tests.

The following typical conditions are assumed:

(a) The product comprises a series of successive purchased lots of a raw material from the same source; normally expected to be of essentially the same quality.

(b) The specified requirements are expressed as maximum and/or minimum limits for one or more chemical characteristics.

(c) For a given characteristic, the normal acceptance procedure for each lot is to obtain a suitable sample of the material and make a lab analysis or test of it. The lot is considered *conforming* if the test results meet the applicable specification requirement, and *nonconforming*, if the test results fail.

PROCEDURE

1. The plan is to be applied separately to each of the characteristics under consideration.

2. For a given characteristic, one of two procedures, A1 or A2, is chosen, depending on what is normally to be done when a lot is found to be nonconforming for that characteristic.

3. *Procedure A1*—Applicable when each nonconforming lot is to be either corrected or replaced by a conforming one:

(a) At the outset, test every lot consecutively as purchased

Table I—Comparison of Terms for Two Sampling Plans

CSP-1 (product units)	SkSP-1 (lots of a raw material)
series of units	series of lots (or batches)
inspect a unit	make lab analysis of a sample of material
defective unit (a unit which fails to meet the applicable specification requirement)	nonconforming lot (a lot whose sample fails to meet the applicable specification requirement).
units in succession found clear of defects	lots in succession found conforming
incoming % defective: % of incoming units that are defective	incoming % defective: % of incoming lots that are nonconforming
meaning of 2% AOQL: an average of not more than 2% of accepted units will be defective for the characteristics under consideration.	meaning of 2% AOQL: an average of not more than 2% of accepted lots will be nonconforming for the characteristic under consideration.

and continue such testing until 14 lots in succession are found to be conforming. (See Note 1.)

(b) When 14 lots in succession are found to be conforming, discontinue testing every lot and instead, test only half of the lots. (See Note 2.)

(c) If a tested lot is found to be nonconforming, revert immediately to testing every succeeding lot until again 14 lots in succession are found conforming as in paragraph (a).

(d) Either (1) accept each nonconforming lot after it has been made conforming by reprocessing and correction, or (2) replace the nonconforming lot by a conforming lot (see Note 3).

4. *Procedure A2*—Applicable when each nonconforming lot is to be rejected and is not replaced by a conforming lot:

(a), (b), (c) same as paragraphs (a), (b), and (c) above, except replace "14 lots in succession" by "15 lots in succession."

(d) Reject and remove each nonconforming lot.

Note 1—AOQL Value:

This is an application of continuous sampling plan CSP-1 with an AOQL of two percent in which

f = ½ (fraction of lots to be inspected during sampling)

i = number of successive lots to be found conforming

= 14 for Procedure A1 (the published CSP-1 procedure)

= 15 for Procedure A2*

Under this plan, in the long run, an average of not more than two percent of the accepted lots will be nonconforming. A 2% AOQL value is proposed as a standard value for this application. However, if desired in specific cases, other CSP-1 plans such as the following may be used:

AOQL	f	i Proc. A1	i Proc. A2
Standard Plan			
2%	1/2	14	15
Other Plans			
3%	1/2	9	10
5%	1/2	5	6
5%	1/3	9	10
5%	1/4	12	13

For other choices of f and i, see Fig. 1 which gives curves for Plan CSP-1 corresponding to Procedure A1 above. These curves may be helpful for making choices in other applications of Plan SkSP-1.

Note 2—Selection of lots to be tested during sampling

The theoretically best way of selecting lots to be tested during sampling is to use some 50-50 chance device (toss a coin, draw a card from a pack of cards, etc.) to determine for each lot whether it should be tested for the characteristic under consideration. Every lot will thereby be a potential candidate for acceptance testing. Such procedure is recommended in order to prevent possible misuse of the plan. Testing *every other lot* would be satisfactory, for example, *provided* only that knowledge of the sampling schedule would not be used to unfair advantage, as, for example, by submitting individual non-conforming lots at times when testing is to be omitted. For f values other than ½, such as ⅓ or ¼, a satisfactory method of selection is to draw a card from a properly composed pack of cards or to draw a chip from a bowl containing correct proportions of red and white chips.

Note 3: Acceptance of nonconforming lots

In specific cases there may be justification for accepting a nonconforming lot. However, such action is outside the statistical framework of the plan; the upper bound to the

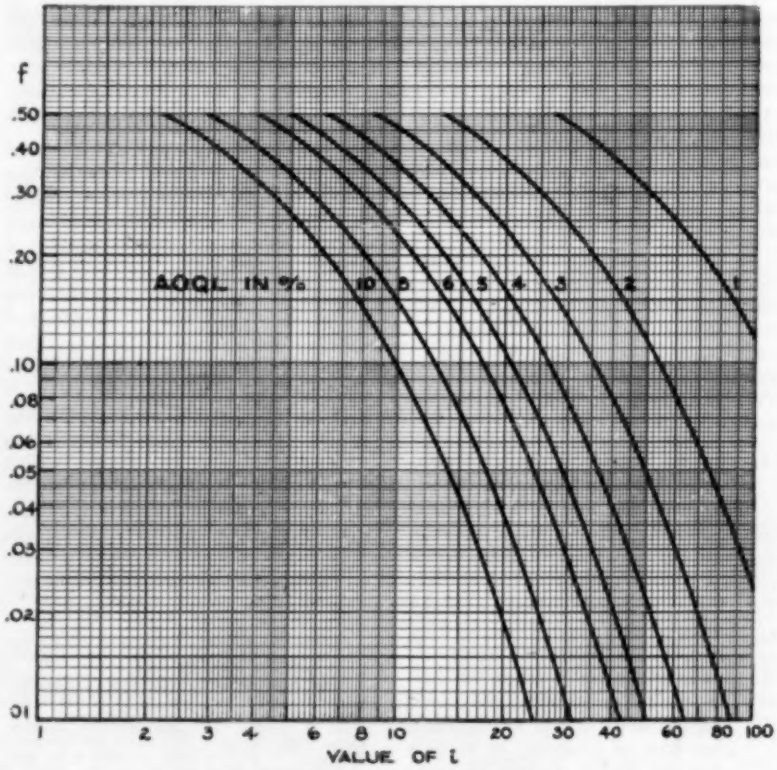

Figure 1—Basic Curves for Plan CSP-1

*It can be shown that i should be increased by one in CSP-1 plans when defective units are removed but not replaced.

"average percentage of accepted lots that will be nonconforming" will no longer be given by the AOQL value of the plan.

COMMENTS ON APPLICATION

Treatment of Several Characteristics.—If a product has a number of characteristics as, for example, several chemical constituents with specified limiting percentages, there is no necessity for applying the plan simultaneously to all of these characteristics. It may be applied to one alone if that is particularly well-controlled or it may be applied to just two of the group. Interest will generally center on applying the plan to those characteristics which involve the most difficult analytical procedure or the most costly analysis.

If the plan is applied to several characteristics of a given product, two or more characteristics may be on a sampling basis at the same time. In such cases, during sampling, it would be preferable to avoid omitting all qualified tests on some lots and performing all such tests on others. For example, if f is the same, say ½ for all specified characteristics under consideration, and if all characteristics have qualified for sampling, it would be a preferred practice to make some tests on every lot rather than to omit all tests on half of the lots and to perform all tests on the other half. Judgment should be used in spreading the testing schedule.

Continuing Supply.—The plan should be thought of as applying primarily to a continuing supply from a uniform and substantially continuous process. This condition often exists within a plant where one department furnishes material to be used by another. Intermittent purchases from a common source, say, for example, one shipment of a special alloy steel per quarter, would not ordinarily be expected to be a candidate for the use of the plan. On the other hand, if there were intermittent purchases of each of several types of material from the same source, and if experience indicated that all types had consistent conformance to specification for a given characteristic, say, percent carbon, then this over-all consistency of source might, on an engineering judgment basis, be taken as adequate grounds for applying the plan to a collective group of materials.

Adaptation to Other Lot Sampling Plans.—The plan is readily adapted for use with respect to tests for physical characteristics of raw materials. It can be used whether the acceptance of a lot is based on results of testing a single specimen or composite sample or on the results of testing several specimens. When acceptance is based on testing several specimens, it is merely necessary to define what constitutes a criterion of nonconformance as, for example, (a) failure of one or more specimens, (b) failure of more than one specimen, etc.

Application of Quality Control in the Manufacture of Electrical Cable

C. KENNETH HAMLIN

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INTRODUCTION

In many ways, the quality control engineer in the wire and cable industry is a very unfortunate individual. In the first place, the product he must work with does not readily lend itself to standard sampling plans. Finished lengths of cable can only be sampled on each end regardless of the amount of cable involved. Secondly, many of the inspection characteristics involved are judged using micrometers or other precision tools on "soft" materials. Hence, the ever present problem of accuracy and variability in measurement. These and other problems are not insurmountable however, and we are developing and using statistical sampling plans and methods with success.

This paper may be regarded as a page from our diary of experiences at Rome Cable. The sampling plans or procedures described are neither complicated or new. They are, however, actual applications that have proved successful and are presented with the hope that the reader will gain some benefit from our experiences. We shall try to show how we have applied simple quality control methods to advantage in the manufacture of a special type of communications cable assembly.

SPIRAL-4 CABLE

As a preface to this discussion, it may be beneficial to become familiar in a general way with the cable itself.

This cable is commonly called Spiral-4 Cable. The military designation is WF-8/G. (See Fig. 1). The cable is made up of four stranded copper conductors each of which is insulated with polyethylene. For polarity identification, two of these conductors are insulated with natural polyethylene, and two with brown polyethylene. Four insulated conductors are then twisted around a polyethylene filament, called the core, and encased in a belt of polyethylene. A carbon impregnated cloth stabilizing tape is then folded around the belted assembly and a 16-end stainless steel braid applied. Over the braid is extruded a vinyl plastic jacket.

This cable is classified by the military as non-permanent, even though it may be used for many years. It is capable of being stored for long periods and will withstand many hardships such as temperatures from −67°F. to +140°F. It may be laid out on the ground, buried underground, under water, or strung on poles. The cable is small in diameter, being only slightly larger than a lead pencil, and yet will withstand a stress of around 700 lbs.

As a communications cable, it will carry 12 two-way telephone conversations at one time, or a total of

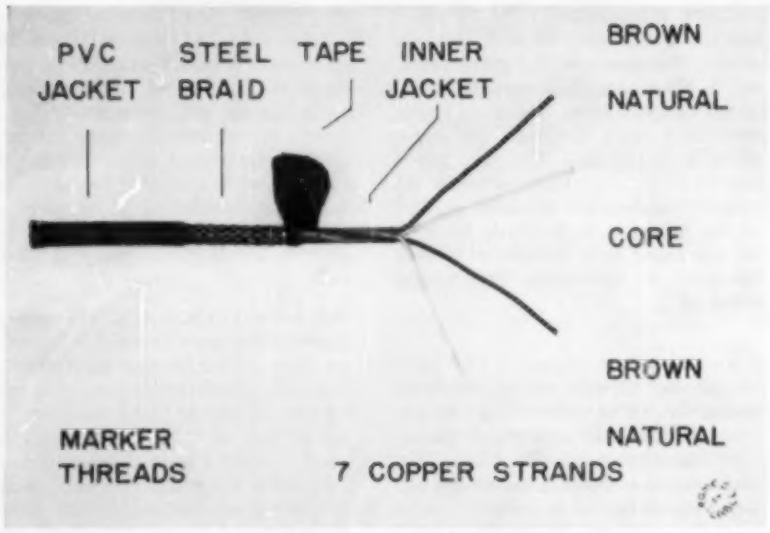


Figure 1—Spiral-4 Cable

384 teletype messages can be sent over one cable at the same time.

To achieve these rather startling results, the cable must be capable of meeting many exacting requirements. From a manufacturing standpoint, many of the factors that influence various electrical characteristics are extremely sensitive. For this reason, our process inspectors have a great responsibility in the manufacture of this cable. It is in this connection that we have benefited most from quality control procedures.

Referring again to the description of the cable, the basic component is the stranded conductor. In the finished cable, and among other things, these conductors must be within limits for copper resistance. The specification also places a maximum value for the ratio of the AC resistance (at 60 Kilocycles) to the DC resistance. The DC resistance of a copper wire varies inversely as the square of the diameter. To meet the copper resistance values then, it would seem in order to use wire of such a diameter that you would hit the middle of the limits for this test. This is not too difficult in itself. It was decided, however, that the AC/DC ratio requirement could most safely be met by keeping the DC resistance high.

This, in fact, is our procedure. Because of other facts, which are probably not important for this discussion, we decided that the ratio problem was one of the most critical of these tests. We therefore set limits for copper resistance much tighter than those required by the government specification.

METHOD OF DRAWING

Before considering our methods for controlling this resistance value, it might be well to examine the wire drawing process which, of course, determines the wire diameter and therefore the DC resistance.

Wires of this size, approximately 13.6 mils (0.0136") in diameter, are cold-drawn with great uniformity of diameter. As in all processes, however, some variation is to be expected. Most of this variation is due to the dies through which the wire is drawn. Even though diamond dies are used in this operation, some wear is inevitable. As this wear takes place, the wire drawn gradually increases in diameter.

Theoretically then, the problem reduces itself to that of using the correct die size and replacing it when worn. From a practical or economic view, diamond dies are expensive, so reasonable allowances for wear are essential. Therefore, the wire drawing department must be given some tolerance with which to work. For wires of this size the desired tolerance was approximately 0.4 mils (0.0004").

Now consider the fact that we must also allow for some "pull-down" or reduction in diameter of the conductor from subsequent operations. This figure, which in our case amounts to little over 0.1 mil, is more or less stable and once allowed for, gives little difficulty.

Because we realized that we must live with some variation in diameter of the wire from the wire drawing department, we decided to make this variation work for us if we could. The problem was to find a way to allow a variation of 0.4 mils in the drawing process, when our calculations proved 0.1 mil to be the permissible variation with respect to ultimate resistance values.

To overcome this problem, we issued a specification stating absolute values for minimum and maximum diameter (using the desired 0.4 mil spread), and requiring that the measured average diameter of wire being produced from all machines be 13.7 plus or minus 0.05 mils. We further specified, and this is very important, that the output from all machines be placed in random order on skids for transfer to the stranding department. This randomizing of the output from all machines was very successful and guarded us against receipt of concentrated lots of strand near our tolerance limits.

CONTROLLING THE DIAMETER

So far, we have not considered in any detail how the inspection job is done. Perhaps we should first examine the method of measurement. The basic instrument used in the drawing department is a one inch micrometer graduated to read to the nearest ten-thousandth or 0.1 mil. For our purpose, however, this is not accurate enough, since we need to know accurately the diameter to four places. This requirement was readily met by the use of a barrel micrometer, with which it is possible to measure with good accuracy to the nearest 0.05 mil (0.00005"). A barrel micrometer, however, is not the handiest type of instrument for process inspection in the shop. In this case, however, its use cannot be avoided and it is used regularly for this inspection. Knowing the normal time for die wear, we require that at set intervals the output of all machines be measured with a barrel micrometer. The average diameter at that time must be within this tolerance. If not, a die change is made.

In the stranding department we have been able to overcome some of these difficulties. In fact, we have been able to do away with the micrometer entirely and yet obtain accurate results. Because each skid of wire delivered to the stranding machines was the thoroughly intermixed output of the entire bank of wire drawing machines, the average diameter of the wire on the skid was known to be within limits. The operator at the stranders selects at

random, without using a micrometer, the seven spools needed to set up a machine. In this manner, we find we can predict within very close limits, just what the average diameter of the seven spools will be.

Since the resistance is really the thing we want to control, we devised a procedure for measuring the resistance of small samples taken directly from the stranding machines. This procedure makes use of a test box so designed that the temperature and length of sample are accurately controlled during the test. The values thus obtained are extended in terms of predicted resistance in the finished cable. In this manner we know what the finished cable resistance values will be before the strand is insulated.

These values are recorded and plotted on simple $\bar{X}$ and R charts by the inspector. (See Fig. 2). We use averages of four for plotting, and use 2-σ control limits for greater sensitivity. We have found these charts very valuable and easy to maintain. In our case, the 2-σ control limits were recomputed at regular intervals at the start of this program, but when the process stabilized at a satisfactory level the limits were "frozen" and have remained fixed since that time. Through the use of these control charts we have been able to keep the copper resistance values of the finished cable within very close tolerances. The problem of passing AC/DC ratio tests is practically non-existent.

CONTROLLING THE INSULATION

The insulating of the stranded copper conductors is also a critical operation, because the positioning of these conductors around the core and their relation to each other influences the capacitance values of these conductors. A perfect cable would be one in which each of the four conductors was insulated to exactly the same diameter and with perfect concentricity of insulation. This, of course, is next to impossible, but it is possible to reduce this variation to a minimum. Once reduced to a satisfactory level, the problem again is one of control.

At this insulating process we have used, with very good results, simple control charts for individuals. (See Fig. 3). These charts are maintained jointly by the operator and inspector. The control limits used are modified limits derived after a careful study of machine capabilities. To compare our diameter control limits for individuals with specification limits, we use limits of 0.076" for the lower limit and 0.078" for the upper limit. Specification limits are 0.073" and 0.079" respectively.

It is worthwhile mentioning, at this point, that these charts were very valuable in the training of inexperienced operators and inspec-

QC – 102

OPERATOR NO. 1234 MACHINE NO. 10

D. C. RESISTANCE

DATE	8/16/52					8/17/52				8/18/52				
SAMPLE NUMBER	16.46	16.46	16.59	16.46	16.42	16.46	16.70	16.66	16.46	16.34	16.50	16.59	16.66	16.66
	16.50	16.62	16.66	16.59	16.50	16.66	16.46	16.42	16.30	16.50	16.55	16.34	16.30	16.46
	16.30	16.62	16.55	16.50	16.66	16.46	16.21	16.42	16.34	16.62	16.70	16.38	16.38	16.50
	16.46	16.42	16.62	16.23	16.46	16.46	16.38	16.34	16.23	16.50	16.34	16.42	16.70	
Σ	65.72	66.12	66.42	65.78	66.04	66.04	65.75	65.84	65.33	65.96	66.09	65.73	66.04	
$\bar{X}$	16.43	16.53	16.60	1644	16.51	16.51	16.43	16.46	16.33	16.49	16.52	16.43	1651	
R	0.2	0.2	0.1	0.4	0.2	0.2	0.5	0.3	0.2	0.3	0.4	0.3	0.4	
σ														

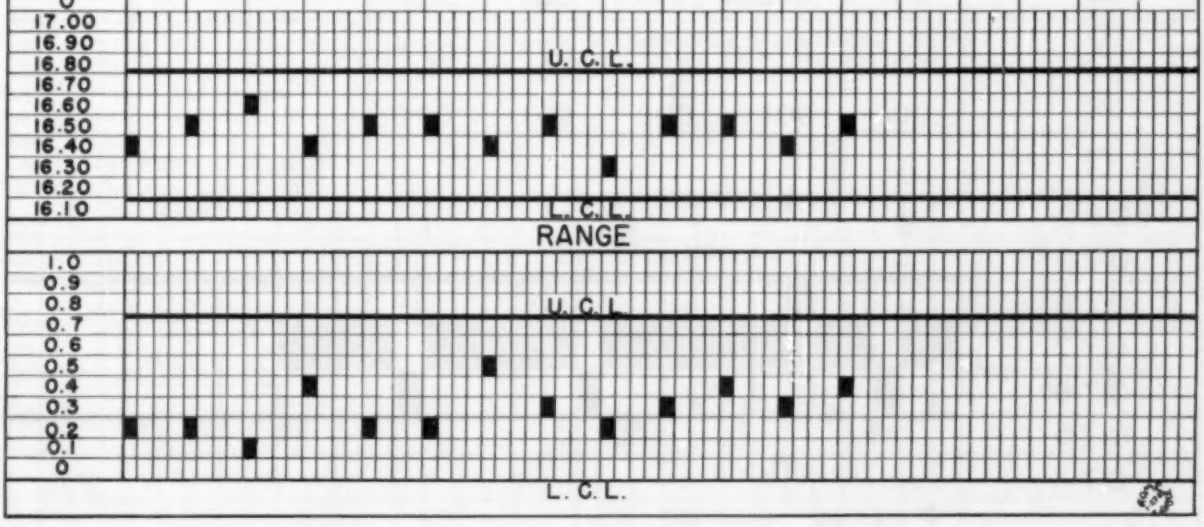


Figure 2—Control Chart for DC Resistance

tors. The measuring instrument used in this case is a one inch micrometer. Those of you who have had experience with a micrometer in the measuring of soft materials will readily understand the problem. Considerable time is required to acquire the sense of "feel" necessary to make an accurate measurement.

Stated simply, our procedure required that the operator first obtain a sample, measure the diameter, and plot the measurement on the chart. The inspector then obtained a measurement of the same sample and plotted results.

In actual operation, the operator plotted his measurement by completely filling in a small square on the chart with a pencil. If the inspector agreed with his measurement, she did nothing. If her results were different, however, she placed an x in the appropriate square indicating her measurement. The result was that differences in measurements were apparent to supervision and action could be taken to reconcile these differences. For some time during this training period all samples were saved and carefully measured by a qualified inspector using a micrometer microscope. Summaries were prepared and attention was given to those who needed it.

These daily charts are also arranged to cover three shifts. This proved especially valuable during the initial training period, as it enabled operators to compare their work and stimulated operator interest and awareness of quality.

The procedure just outlined for the insulating process is also used at the belting and jacketing operations. These operations are very much the same as the insulating process except the core size over which the material is being applied is larger. The problems faced by the inspection department are much the same.

CONTROLLING ELECTRICAL CHARACTERISTICS

The requirements for various electrical characteristics of this cable are very critical. The tests performed on the cable at this point are measurements of mutual capacitance, side-side capacitance unbalance, side-ground capacitance unbalance, copper resistance and a dielectric strength test. With the exception of the dielectric strength test, these are all bridge measurements, requiring the use of precision laboratory instruments involving delicate balance of a galvanometer or null detector.

Each of these tests requires connecting the cable to a particular unit of test equipment, and in each case the connecting circuit is different. In an effort to facilitate this testing, and to reduce the chances of error caused by the constant connecting and reconnecting of the cable to each of the instruments, we conceived the idea of combining the several bridges into one unit so arranged that all tests could be performed with one hook-up. Changing from one test hookup to another, would then be accomplished by means of selector switches and remote-controlled relays.

Our specifications for this unit were given to the Power Equipment

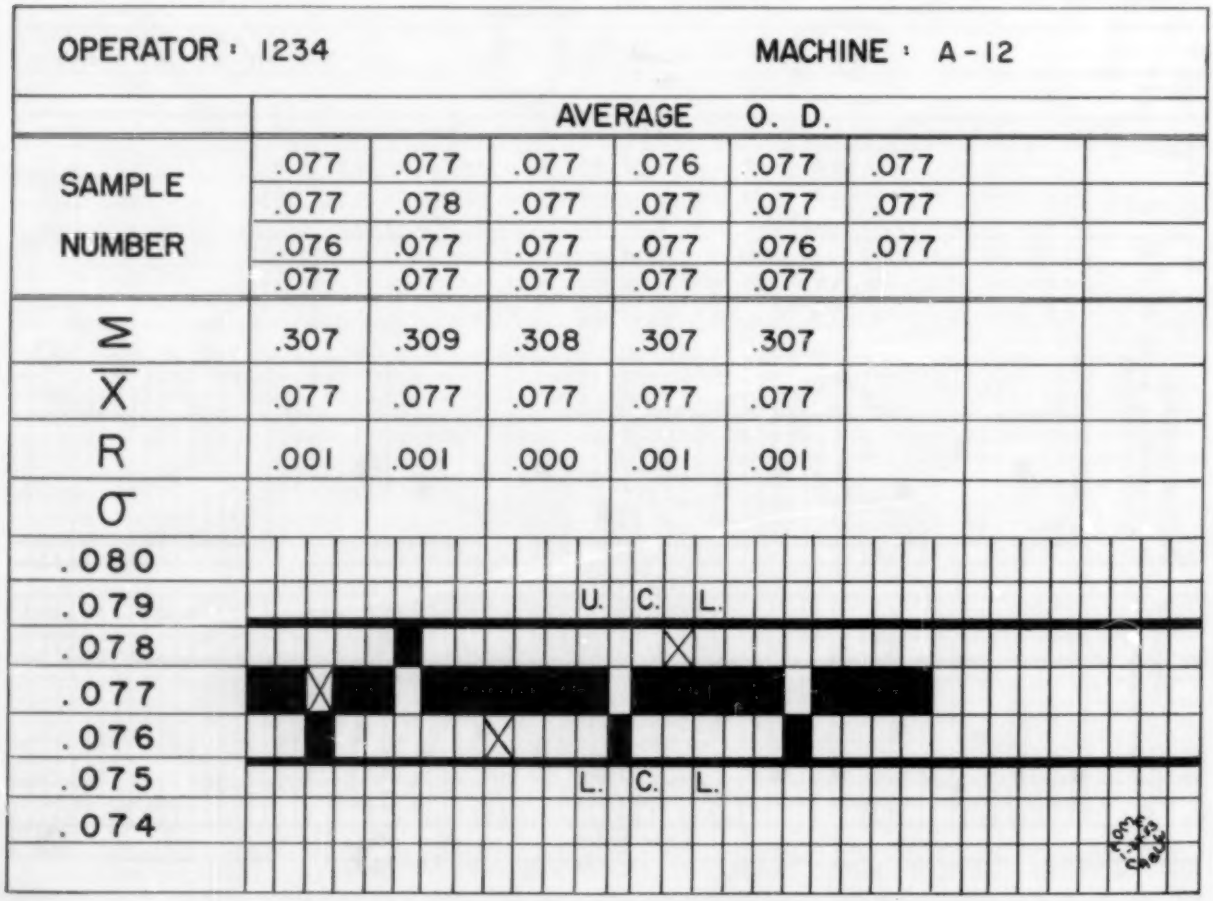


Figure 3—Control Chart of Individuals for Insulation Diameter

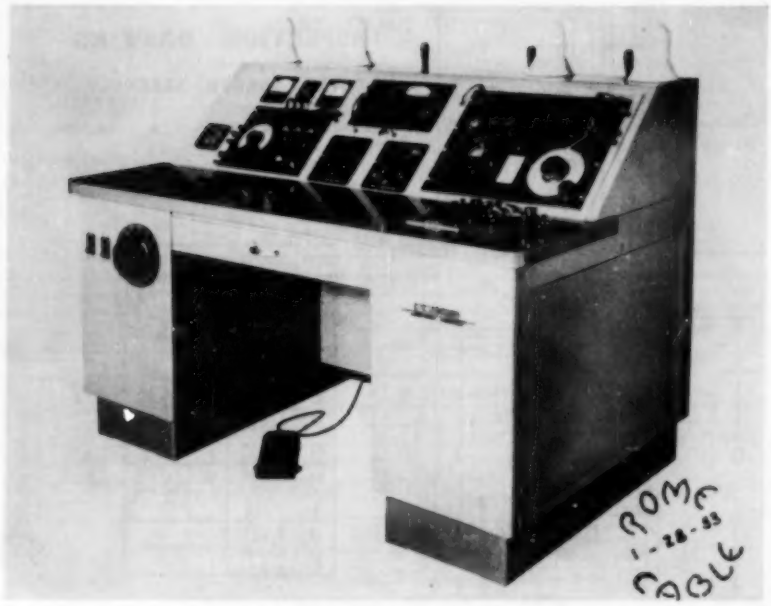


Figure 4—Special Cable Testing Consoles

Company of Detroit, who worked out the rather complex circuitry and assembled seven of these units which we call test consoles. (See Fig. 4). These consoles are basically a metal desk of modern design with the test instruments built in. The instruments have been carefully arranged on a sloping panel for maximum convenience of the operator.

For this discussion we will not go into any detail with regard to the tests themselves, but it should be noted that each of these tests is critical, and that individual values recorded for a given length of cable must be accurate. Because the electrical connection between the cable under test and the measuring instrument is accomplished by means of many switches and relays, certain errors must be expected. We have made careful studies and have reduced these errors to a minimum. To keep the errors at a minimum, daily checks are made on each console using a calibrating hook-up of our own design.

The other errors to be considered at this point are operator errors, which can be described as either mathematical or errors in measurement. We realized at the outset, that because of the amount of concentration and mental effort required, severe mental fatigue was inevitable. This condition is further aggravated by the necessity of using a slide rule frequently to convert or extend results into standard units. Recognizing these problems as ones that could not be entirely eliminated, we set about to devise a system of control. Although several methods were tried, with varying degrees of success, the method we are now using has proven the best.

This procedure, which is a retesting procedure, makes use of Dodge's plan for Continuous Sampling. (See Fig. 5).

The operation of a continuous sampling plan is briefly as follows:

(1) At the outset, inspect 100 percent of the units consecutively until "x" units in successsion are found clear of defects.

(2) When "x" units in succession have been found clear of defects, discontinue 100 percent inspection, and inspect only a fraction "f" of the units, selecting these individuals one at a time from the flow of product.

(3) If a sample unit is found defective, revert immediately to 100 percent inspection of the succeeding units and continue this inspection until again "x" units in succession are found clear of defects, then proceed with the sampling inspection as outlined before.

In our case, we consider a defective to be a calculation or instrument reading outside predetermined limits. Thus, a "defective" does not mean defective product, but rather a "defective test." These limits have been arrived at after careful study of instrument variation and have been tempered with some good old-fashioned "horse sense."

There are two very real advantages of this system. First, since this rechecking is carried on simultaneously with the actual testing, errors are detected quickly and the necessary corrections are made before the test reports are completed. Secondly, errors caused by malfunctioning of relays, switches, or other console components are quickly noted and corrective action taken.

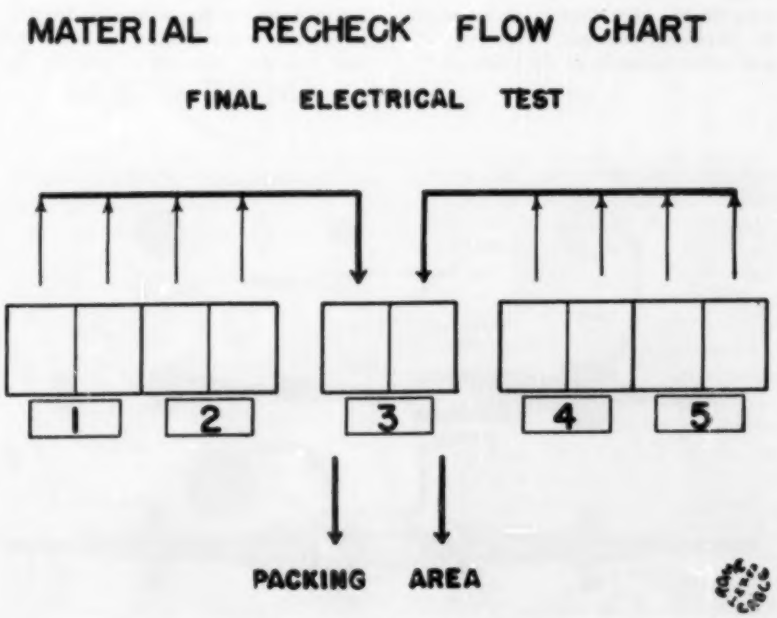


Figure 5—Material Recheck Flow Chart

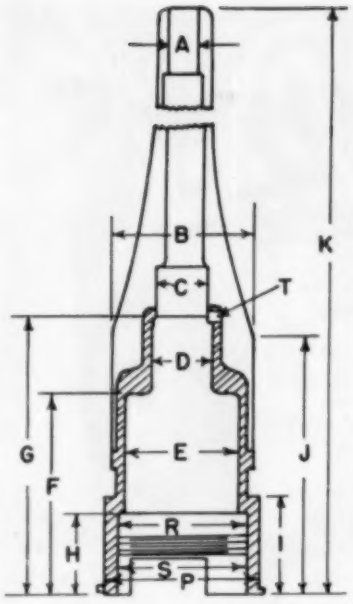
The results of this rechecking plan have been very gratifying. Because of the critical nature of these tests, in all probability we would have been forced to hold tested material in lots and subject it to a sampling recheck if this continuous type plan had not worked so successfully. This, of course, would have necessitated storage areas, time delays, and a great deal of rehandling of tested material. This problem would be even more acute in our case because of our continuous operation.

Briefly, then, the value of this rechecking system is two-fold: first, the government agency is well protected against receipt of defective material, and second, the manufacturer is constantly aware of testing efficiency.

PURCHASE OF CABLE TERMINATIONS

For convenience, this cable is supplied in uniform lengths with terminations at each end. The standard length is in one-quarter mile. The connector, which is attached to each end, provides a secure method of connecting one length to another in the field. Several lengths, so connected, provide the necessary length of cable to connect two locations.

The connector itself is an assembly consisting of approximately ten main parts. Figure 6 illustrates quite well the detail and compactness of the terminating connector. The connector provides a mechanical and electrical connection between two lengths of cable that is as resistant to physical damage, moisture, dirt and other hazards, as the cable itself.



INSPECTION DRAWING

COVER MOLDED ASSEMBLY

REF.	DIMEN.	REF.	DIMEN.
A	0.330 0.325	L	74°45' 74°30'
B	1.625 1.623	M	104°45' 104°30'
C	0.640 0.610	N	1.067 1.057
D	0.760 0.750	P	1.780 1.747
E	1.380 1.370	R	1.503 1.500
F	0.375 0.248	S	1.345 1.333
G	3.265 3.234	T	DOWEL PIN
H	1.036 1.026	W	1.500 1.495
I	1.192 1.182		
J	3.080 3.068		
K	8.693 8.824		

Figure 7—Inspection Drawing of the Cover Assembly for Terminating Connector

Our experiences with this connector have been very educational. In the first place, this was practically our first experience dealing with the inspection of machined parts. Secondly, it was our first experience in the assembly of these parts. These very facts serve to emphasize that without the help of certain statistical sampling plans and quality control procedures we probably would not have achieved the fine quality record that we now enjoy.

Since we are the prime contractor, it is our responsibility to seek out and approve sources of supply for connector parts. Once these suppliers have been obtained, it is our job to assemble the connectors and produce acceptable cable assemblies.

The first problem, then, is one of supply. Interested suppliers are asked to furnish us with perhaps 10 or 12 samples of a given part or assembly. These samples are inspected very carefully, and may be submitted to a government agency for comments. If the samples are acceptable, we then ask the supplier to submit 200 units from a production run. These parts are also subjected to our most comprehensive inspection. If the results of this inspection are satisfactory, and we feel that the supplier is fully informed of our needs and that he is capable of producing parts of acceptable quality, he is so notified and permission is granted to ship in larger quantities.

To accomplish the inspection of incoming materials from this point on, we have set up sampling plans drawn from MIL-STD-105A.

To facilitate the inspection job, we first listed for each part all characteristics or dimensions involved. These characteristics were then classified as to their importance into three categories; that is, Critical, Major, and Minor. We then decided upon the appropriate quality level for each of these classifications. In our case, the levels used are 0.1% for critical defects, and 1.0% for

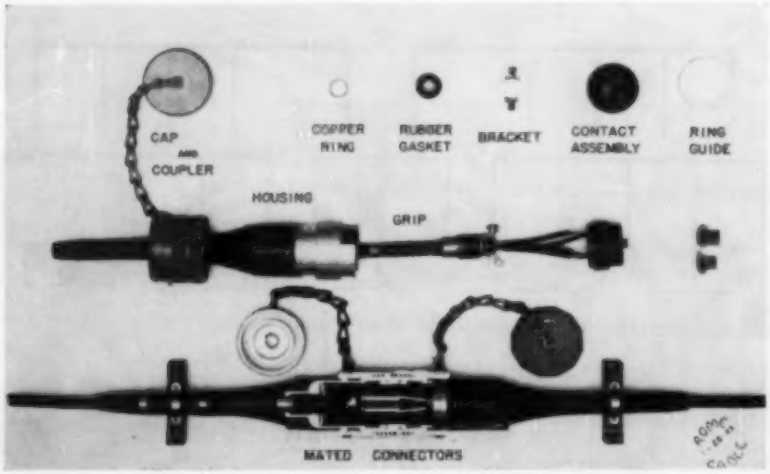


Figure 6—Cable Terminating Connector

ROME CABLE CORP.

INCOMING MATERIAL - QUALITY RECORD

MATERIAL _____ SPEC. OR DWG. NO. _____

AMOUNT RECEIVED	DATE	1 ST SAMPLE			2 ND SAMPLE			LIST OF DEFECTS					REMARKS
		SIZE	DEFECTS ALLOWED	DEFECTS FOUND	SIZE	DEFECTS ALLOWED	TOTAL DEFECTS FOUND	1	2	3	4	5	

LIST OF DEFECTS	DISPOSITION
1	A - TRANSFER TO STOCK
2	B - HOLD FOR 100% INSPECTION
3	
4	
5	

Figure 8—Inspection Report Form

major and minor defects. For the convenience of our inspectors, we have produced in ditto form, a drawing of each part showing all dimensions. (See Fig. 7). A combination instruction-report form was also devised. (See Fig. 8).

Once the initial sample of 200 units had been accepted, subsequent shipments are sampled and inspected according to the plan just outlined. We use Inspection Level II and use a Tightened Plan until the process average indicates that Normal or Reduced inspection is in order.

The results of this inspection procedure have been very gratifying. We tend to detect very quickly any deterioration in quality or change in supplier's methods. Seldom do defective parts turn up in our assembly operation. In short, we have found that the advertised benefits of a good statistical sampling plan are there if the plans are used with judgment and good common sense.

As a sidelight to this discussion, the incoming materials inspection plan for connector parts just outlined is administered by a man who previously had no experience with statistical quality control. His complete confidence in these procedures and ability to use them successfully is a tribute to the usefulness of statistical quality control methods.

CONCLUSION

During the past two years we have gained considerable experience with quality control procedures in our field and we feel convinced that wider applications of statistical procedures are possible. As a matter of fact, many technical bodies such as the American Society for Testing Materials are studying and even now incorporating statistical procedures in their Standards. The challenge to those of us in the wire and cable industry is to promote the progress and usefulness of statistical quality control procedures by continued study, application, and the reporting of results to the Society.

References:

(1) "A Sampling Inspection Plan for Continuous Production"—H. F. Dodge.

(2) "MIL-STD-105A" — Military Standard.

(3) "ASTM Manual on Quality Control of Materials"—American Society for Testing Materials.

SQC AT ESO

Mr. Leslie P. Sorensen, Statistical Branch Supervisor at the Electronic Supply Office (ESO), Great Lakes, Illinois, reports, in a communication under date of October 27, 1954, on the use of SQC methods at ESO. He says, in part, "Statistical quality control was instituted in ESO a year ago. After some experimentation we found it to be an effective and economical technique to improve quality. It is therefore being expanded to all appropriate work operations, and it is anticipated that it will be applied to all such operations in another year."

Applications that have thus far proved fruitful consist of standard control charts with center and control limit lines for work samples taken periodically from various clerical operations. These include:

(1) Work performance by teletype operators in writing messages, Communication Branch, Administrative Services Divisions.

(2) Work performance in the Progress Branch of Stock Control Division.

(3) Keypunch operations in Machine Records Division.

(4) Processing of forms in Catalog Division.

(5) Processing of forms in the Technical Division.

(6) Typing of documents in the Purchase Division.

The part played by the Statistical Branch in putting SQC to work at ESO is described by Mr. Sorensen as follows: "The Statistical Branch conducts surveys in work areas in ESO to determine the propriety of Statistical Quality Control. The Statistical Branch then proceeds to implement SQC in all appropriate areas. This consists of selecting samples, determining types of errors, completing data sheet, preparing charts and posting thereto. This is done in collaboration with operating personnel so they can learn all the procedures required for its perpetuation after two to four weeks, at which time the Statistical Branch merely monitors the program."

Some Notes on the Theory and Application Of Rank Order Statistics*

Part I

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INTRODUCTION

Rank Order Statistics is that body of statistical methodology that may be used in the summarization and analysis of data that consist only of orderings or rankings of observations or of subsets of observations. When we speak of ordering in this paper, we mean an ordering of numerical observations, or perhaps of items themselves, with respect to the sizes of the numerical observations or to the magnitudes of stimuli of some sort produced by the items. Order of occurrence or order in time is not our concern here and is of no interest except in possible applications of rank order methods wherein order of magnitude of observations coincides with order in time. When observations are arranged in order of magnitude and when the i^{th} observation is the j^{th} largest, we say that the i^{th} observation has the rank j. The original data may have been obtained directly as ranks, or quantitative numerical observations may have been replaced by ranks for a variety of reasons.

Some of the advantages of using ranks have recently been summarized by Kruskal and Wallis[4] as follows:

> "(1) The calculations are simplified. Most of the labor when using ranks is in making the ranking itself, and short cuts can be devised for this. For example, class intervals can be set up as for a frequency distribution, and actual observations entered instead of tally marks. Another method is to record the observations on cards or plastic chips which can be arranged in order, the cards perhaps by sorting devices.
>
> "(2) Only very general assumptions are made about the kind of distributions from which the observations come. . . .
>
> "(3) Data available only in ordinal form may often be used.
>
> "(4) When the assumptions of the usual test procedure are too far from reality, not only is there a problem of distribution theory if the usual test is used, but it is possible that the usual test may not have as good a chance as a rank test of detecting the kinds of differences of real interest."

*Prepared under a Research and Marketing Act Contract, Project RM: c-629-1, with the Bureau of Agricultural Economics.

This article is based on a paper presented to the American Society for Quality Control at the Middle Atlantic Regional Conference, Baltimore, Md., Feb. 5, 1954. To facilitate publication these notes are presented in two parts, the first dealing with analogues of t tests and the second with analogues of the analysis of variance. Part II will appear in the next issue of *Industrial Quality Control*.

At the Virginia Polytechnic Institute we have been interested in ranking procedures as applied to data involving subjective judgments in regard to sensory discrimination and preference. In experimentation of this kind difficulties are encountered in defining suitable scoring scales and in training members of a panel in their use. It has been found that ranking methods circumvent this problem and decrease the actual time required for experimentation.

There are some disadvantages in using ranks. The usual criticism involves the possible loss of efficiency due to disregarding the quantitative nature of differences in observations with adjacent ranks. This is sometimes offset by the fact that the use of ranks reduces both the time of experimentation and the time of analysis so that samples that are enough larger to counterbalance the loss of efficiency may often be economically used. A further disadvantage in some ranking techniques is that they are essentially limited to testing hypotheses and are relatively useless in the estimation of size of treatment differences.

In *Industrial Quality Control*, Wallis[8] has summarized and illustrated the use of some of the better known rank order methods in a discussion of rough-and-ready statistical tests. Here we shall be somewhat selective in the methods discussed and let the reader refer to Wallis' paper for some of the methods that we omit. In this paper, Part I, we discuss analogues of t tests with a view to illustrating the theory of rank order tests and continue in Part II, with less detail, with analogues of the analysis of variance. Terry's work[7] is included since his procedure depends on scores for ordinal (or ranked) data as given by Fisher and Yates[3] in Table XX. Scoring of this type has frequently been recommended as a method of transforming ranks prior to using standard analysis of variance techniques. Durbin[2] has extended the analysis of experiments with ranked data to balanced incomplete block designs and his work is of interest in that it permits the use of these more complex designs with ranks.

RANK ANALOGUES OF THE TWO-SAMPLE t TEST

Kruskal and Wallis emphasize that two kinds of data must be distinguished in discussing tests for the equality of a number of population averages. The two kinds are:

> Type A. Data that consist of independent random samples, one from each population, and
> Type B. Data that consist of samples of equal size from each population that are matched according to some additional criterion that may affect the values of the observations.

When two samples, $X_1, \ldots, X_{n_1}$, and $Y_1, \ldots, Y_{n_2}$ are randomly selected from possibly two different populations, we have data of Type A. If it is assumed that (i) both populations are normal with (ii) homogeneous variances and that (iii) the samples are independent and consist of independent observations, we may use the two-sample t test to test the null hypothesis that the population means, μ_1, and μ_2, are equal against either one-sided or two-sided alternatives. The t statistic is

$$t = \frac{\sqrt{\frac{N_1 N_2}{N_1 + N_2}}\ (\bar{X} - \bar{Y})}{\sqrt{\frac{\Sigma(X_1 - \bar{X})^2 + \Sigma(Y_1 - \bar{Y})^2}{N_1 + N_2 - 2}}} \qquad (1)$$

When one or more of the assumptions for the t test are suspect or if the data occur simply in the form of ranks, we use a rank order test. Wilcoxon[10] seems to have been the first to introduce a suitable test and we shall consider his procedure in some detail.

In two-sample tests of this kind the whole array of $N = N_1 + N_2$ observations are arranged in order of magnitude and replaced by ranks, 1, . . . , N. Let $r_1, \ldots, r_{n_1}$ represent the ranks of the first sample and $s_1, \ldots, s_{n_2}$ be the ranks of the second sample. The sums of ranks may be denoted by Σr and Σs respectively. Wilcoxon defined his statistic to have the value of the smaller sum of ranks. We may without loss of generality suppose that Σr is the smaller sum of ranks and let

$$T = \Sigma r \qquad (2)$$

It is interesting to note that T bears a one-to-one relation to $\Sigma r - \Sigma s$ or to the difference in average ranks, $\bar{r} - \bar{s}$, since

$$\Sigma r + \Sigma s = \tfrac{1}{2}N(N+1),$$
$$\Sigma r - \Sigma s = 2\Sigma r - \tfrac{1}{2}N(N+1),$$
$$\bar{r} - \bar{s} = \frac{N\,\Sigma r}{N_1 N_2} - \frac{\tfrac{1}{2}N(N+1)}{N_2}$$

The assumptions inherent in the use of two-sample ranking tests of this kind are that (i) observations are independent and (ii) the populations of X and of Y are of the same form and differ at most in the values of location parameters. Thus, under the usual null hypothesis, the samples of X and of Y are assumed to come from a single population. The alternative hypothesis is expressed in terms of differences in location parameters and may be either one-sided or two-sided.

Test procedures depend on the distribution of the test statistic under the restrictions of a null hypothesis. In most ranking tests, and in this example, the null hypothesis is interpreted to mean that all possible assignments of ranks to the total N observations are equally likely. Now permutations of the ranks assigned to each sample do not affect the value of T, and N_1 of the N ranks may be assigned to the X-sample in ${}_NC_{N_1}$ equally likely ways with the remaining N_2 ranks representing the Y-sample. Under these conditions the average value of the statistic T, designated by E(T), may be calculated with the average being obtained over all values of T resulting from the ${}_NC_{N_1}$ equally likely, possible assignments of ranks to the samples. The result is that

$$E(T) = \frac{N_1(N+1)}{2} \qquad (3)$$

and values of T less than $\tfrac{1}{2}N_1(N+1)$ indicate possible departures from the null hypothesis.

Significance levels of observed values of T are obtained by counting the different assignments of ranks to the samples that yield values of T not greater than that observed. Although this procedure may be tedious, it can be done for each experiment without reference to tables.

Consider the simple illustrative example given in Table I where $N_1 = N_2 = 5$. Order in the table simply represents the order of listing of the samples and may have been decided on the basis of eas of preparing the list and on no other considerations. In the example, $T = 21$, the smaller of the two sums of ranks, Σr and Σs.

TABLE 1—Ranks for X- and Y-Samples

Order i	X-ranks r_i	Y-ranks s_i
1	3	5
2	7	4
3	1	10
4	2	6
5	8	9
Sums	$\Sigma r = 21$	$\Sigma s = 34$
	$T = 21$	
	$\tfrac{1}{2}N_1(N+1) = 27.5$	

We are interested in the null hypothesis that the X- and Y-samples are really from a single population and we then, for the purpose of testing this null hypothesis, assume that the observed assignment of ranks in Table I is simply a randomly selected assignment of ranks from the ${}_NC_{N_1} = {}_{10}C_5 = 252$ equally likely, possible assignments of ranks. We next consider the total number of assignments of ranks that yield values of $T \leq 21$, and these assignments of ranks may be obtained by interchanging ranks of X- and Y-samples. The array of interchanges with $\Sigma r \leq 21$, along with the corresponding new X-sample ranks rearranged in ascending order and the new values of T, is as follows:

No. of Interchanges	Ordered X-Sample Ranks	T
1. No interchanges	1, 2, 3, 7, 8	21
2. One interchange		
8 with 4	1, 2, 3, 4, 7	17
5	1, 2, 3, 5, 7	18
6	1, 2, 3, 6, 7	19
7 with 4	1, 2, 3, 4, 8	18
5	1, 2, 3, 5, 8	19
6	1, 2, 3, 6, 8	20
3. Two interchanges		
(7, 8) with (4, 5)	1, 2, 3, 4, 5	15
(4, 6)	1, 2, 3, 4, 6	16
(4, 9)	1, 2, 3, 4, 9	19
(4, 10)	1, 2, 3, 4, 10	20
(5, 6)	1, 2, 3, 5, 6	17
(5, 9)	1, 2, 3, 5, 9	20
(5, 10)	1, 2, 3, 5, 10	21
(6, 9)	1, 2, 3, 6, 9	21
(3, 8) with (4, 5)	1, 2, 4, 5, 7	19
(4, 6)	1, 2, 4, 6, 7	20
(5, 6)	1, 2, 5, 6, 7	21

(2, 8) with (4, 5)	1, 3, 4, 5, 7	20
(4, 6)	1, 3, 4, 6, 7	21
(1, 8) with (4, 5)	2, 3, 4, 5, 7	21
(3, 7) with (4, 5)	1, 2, 4, 5, 8	20
(4, 6)	1, 2, 4, 6, 8	21
(2, 7) with (4, 5)	1, 3, 4, 5, 8	21
4. Triple Interchanges		
(3, 7, 8) with (4, 5, 6)	1, 2, 4, 5, 6	18
(4, 5, 9)	1, 2, 4, 5, 9	21
(2, 7, 8) with (4, 5, 6)	1, 3, 4, 5, 6	19
(1, 7, 8) with (4, 5, 6)	2, 3, 4, 5, 6	20

5. No quadruple and quintuple interchanges are admissable.

Including the observed ranking, there are a total of 28 ways in which the X-sample could yield the smaller sum of ranks with $T \leq 21$. The distribution of these values of T, with f representing frequency of occurrence, is

T	f
15	1
16	1
17	2
18	3
19	5
20	7
21	9
Total	28

But the Y-sample could have had the smaller sum of ranks in exactly the same number of ways since it is of the same size, and hence, for a two-sided test, the significance level of the data of Table I is $56/252 = 0.222$. If a one-sided test had been proposed in advance with the alternative hypothesis suggesting that the location parameter of the X-population exceeded that of the Y-population, the actual significance level for such a one-sided test on the data would be $28/252 = 0.111$. It will be noted that these significance levels are only the probabilities of obtaining values of T not larger than the observed value, 21, under the assumptions of the null hypothesis. This procedure conforms to general statistical practise; the observed value of T is considered extreme and the null hypothesis is rejected as false if the significance level is less than some preselected value, commonly 0.05 or 0.01. In practise, if N_1 and N_2 are small, the significance levels of observed values of T may be obtained in a manner similar to this example without undue difficulty. Usually one only lists the possible interchanges and records the total number of such interchanges. The complete array of ordered sets of ranks and values of T is shown here to more fully illustrate the method. Some tables are available to assist the experimenter to avoid these listings and approximations may be used.

It is interesting to note how T is related to other possible test statistics. If the formula for t in (1) had been used with the ranks replacing the original observations, it can be shown that a statistic equivalent to T would result. It is simple algebraically to show that

$$\frac{t^2}{t^2 + N - 2} = \frac{(\bar{X} - \bar{Y})^2 \frac{N_1 N_2}{N_1 + N_2}}{S}$$

where S is the total sum of squares for the combined samples. When ranks are used, $\bar{X}$ and $\bar{Y}$ are replaced by $\bar{r}$ and $\bar{s}$ and S is a fixed constant independent of the ranking.

$$S = (N - 1)\, N\, (N + 1)/12$$

and we have the proportionality,*

$$\frac{t}{\sqrt{t^2 + N - 2}} \propto (\bar{r} - \bar{s}).$$

Through the relation previously established between $T = \Sigma r$ and $\bar{r} - \bar{s}$, it is now evident that a one-to-one relationship exists between t and T and the statistics produce equivalent rank order tests.

Mann and Whitney[5] proposed an alternative ranking test for this type of two-sample problem. Their test in its original form is one-sided. The alternative hypothesis is that the location parameter for the Y-population is larger than the location parameter of the X-population. The combined samples are arranged in ascending order with the identity of the samples preserved. For example, for the data of Table I, we have the array YYXXYYYXXX. Mann and Whitney define a statistic U equal to the number of times a Y precedes an X. If a two-sided test is required, U should be defined to be the smaller of the number of times a Y precedes an X and the number of times an X precedes a Y. Then, for the data of Table I in the array above, U = 6.

The U statistic is also equivalent to the Wilcoxon T. Suppose that the X-sample has the smaller sum of ranks. Then $T = \Sigma r$. The smallest possible sum of ranks for the X-sample is $\frac{1}{2}N_1(N_1 + 1)$ and an X precedes a Y once for each unit increase in the value of T. Thus,

$$U = \Sigma r - \tfrac{1}{2}N_1(N_1 + 1)$$
$$= T - \tfrac{1}{2}N_1(N_1 + 1)$$

This may be verified in the example; U = 6, T = 21, and $N_1 = 5$.

We have illustrated the calculation of significance levels for observed rankings for the Wilcoxon test. Wilcoxon[11] has provided tables with $N_1 = N_2$ for five percent, two percent and one percent significance levels of T. It will be noted that the levels of significance do not fall exactly on these levels and this is a feature of rank order tests resulting from the discreteness of the distributions of the statistics. Mann and Whitney give one-tailed significance levels for U (which should be used instead of T if convenient) for all pairs of samples for which the larger sample size does not exceed eight. If a two-sided test is required, probabilities given in these tables should be doubled. Tables of critical values of T at two-tailed significance levels of 5, 1, and 0.1 percent for all sample sizes in which $N \leq 30$ are given by White.[9] White suggests that, when tied observations occur, it will be satisfactory to replace them by the average rank of the tied values. If tables are not available, for moderately large values of N_1 and N_2, Wallis[8] uses

$$u = \frac{2T - n(N + 1) \pm 1}{\sqrt{n(N + 1)\,(N - n)/3}} \qquad (4)$$

where n is N_1 or N_2 depending on whether T is the sum of ranks for the X-sample or the Y-sample. The sign of

*The symbol $\propto$ is read "is proportional to".

unity in the numerator is chosen to give u the smaller numerical value and u is assumed to be a standard normal deviate. In the example T = 21, n = 5, N = 10, and

$$u = \frac{2(21) - 5(11) + 1}{\sqrt{(5(11)(5)/3}} = -1.25.$$

For a two-sided test, using normal tables, we obtain Pr ($|u| \geq 1.25$) = 0.211 and this is in good agreement with the exact significance level computed above.

In selecting a test procedure some assurance is required that it is a good one. The properties of rank order tests are sometimes difficult to investigate and it is particularly difficult to evaluate the powers of such tests for small samples. Kruskal and Wallis have summarized the known properties of the Wilcoxon T test and perhaps the most interesting of these relates to its asymptotic efficiency. When compared with the two-sample t test for cases where the t test could be validly used, the asymptotic efficiency of the Wilcoxon test is $3/\pi = 0.955$. Crudely, this is the limiting ratio of sample sizes necessary for the two tests to attain equal and fixed powers.

We shall return briefly to the Wilcoxon test for a more elaborate example in a later section.

A RANK ANALOGUE OF THE PAIRED-SAMPLE t TEST

When observations in two samples are paired and tests of hypotheses on the means of the two populations generating the samples are required, it is appropriate under conditions of independence and normality to apply the Student t test to the single sample of observed differences between corresponding observations. Such data may be classified as Type B. We shall consider the sign test, an analogue of the Student t test, since the sign test is well known and easy to use.

For paired observations the usual assumptions for the sign test are that the observed differences are independent and come from a single population. The null hypothesis, corresponding to the hypothesis that the population of differences has zero mean, is that the population of differences has zero median. The alternatives again may be one-sided or two-sided and are expressed in terms of the quantile of the population of differences represented by the origin.

Observed differences are replaced by the sign of the difference for the sign test and the statistic used is X, equal to the number of positive or negative signs for one-sided tests, or the larger of the two for a two-sided test. Clearly, if the null hypothesis is true, for a sample of differences of size N, the expected number of positive or negative signs is N/2. Large values of X are regarded as significant. The distribution of X is binomial with $p = \frac{1}{2}$ under the null hypothesis (p may be taken to be the probability of a positive difference). Tables of the binomial distribution have been prepared by the National Bureau of Standards[5,7] and Romig[6] and tables of the incomplete beta function may also be used. In practise the normal approximation is usually sufficient and Wallis[8] uses the form,

$$u = \frac{2X - 1}{\sqrt{N}} - \sqrt{N} \qquad (5)$$

which includes a continuity correction. u is taken to be a standard normal deviate.

Occasionally ties will occur due to the essential discreteness of measuring systems and most authors agree that no serious difficulties will result from discarding them if they are not too numerous.

The assignment of positive and negative signs to differences is equivalent to a ranking procedure. For two-way classifications with more than two treatments we shall see that ranking is used within the classes. The assignment of ranks, 1 and 2, to the observations in each pair effects the same division as the assignment of positive and negative signs to the differences and it is therefore correct to regard the sign test as a rank order test.

The limiting relative efficiency of the sign test for situations suitable to the use of Student's test in comparison with that test is $2/\pi = 0.637$ and this is somewhat lower than the comparable figure for Wilcoxon's test. However, recent work by Dixon[11] indicates that the relative efficiency may be considerably higher for small sample sizes. For example, for N = 5 and with a test based on a significance level of 0.0625, the relative efficiency may be as high as 0.960. Dixon shows that the relative efficiency decreases with increasing sample size, with increasingly high levels of significance, and with increasingly marked departures from the null hypothesis.

NUMERICAL EXAMPLE

In Table II we have recorded data on the compressive strength of test cubes of concrete in kilograms per square centimeter. The experimental material consisted of two samples from each of ten batches of concrete. One sample from each pair received a special treatment and test blocks were made from all samples.

TABLE II—Compressive Strength of Test Cubes of Concrete, kg/cm²

CONCRETE										
I	293	311	284	310	305	291	301	279	295	289
II	309	318	317	302	315	296	319	285	303	290
RANKS UNDER CONDITIONS A										
I	7	16	2	15	13	6	10	1	8	4
II	14	19	18	11	17	9	20	3	12	5
SIGNS, II-I, UNDER CONDITIONS B										
	+	+	+	−	+	+	+	+	+	+

The data consist of paired samples with Concrete II representing the special treatment. In statistical analyses we may: (A) assume that batch-to-batch differences in mixes of concrete are insignificant and may be ignored, or (B) take full advantage of the statistical design that retains the identity of paired samples. In both cases the possible effects of the special treatment were unknown.

Under Conditions A we use the Wilcoxon test. Ranks are shown in the second section of Table II and, since $\Sigma r_I = 82$ and $\Sigma r_{II} = 128$, T = 82. Using White's tables we find that T = 78 at the five percent level, T = 71 at the one percent level and T = 63 at the 0.1 percent level for $N_1 = N_2 = 10$. The observed value of T is non-significant at the five percent level. The normal approximation (4) gives

$$u = \frac{2(82) - 10(21) + 1}{\sqrt{10(21)\ (10)/3}} = -1.70$$

and, for the two-sided test, from normal tables* the significance level is 0.089.

*The two-sample t-test with 18 degrees of freedom on the original observations yields a value at the 0.078 level of significance.

Under Conditions B we use the sign test. The signs of the paired differences, Sample II-Sample I, are given in the third section of Table II. It is seen that $X = 9$ and $N = 10$. Binomial tables with $p = \frac{1}{2}$ show that $P(X \geq 9) = 0.0107$ and for a two-sided test the significance level of the observed results is 0.021. The normal approximation (5) yields

$$u = \frac{2(9) - 1}{\sqrt{10}} - \sqrt{10} = 2.21$$

and the approximate significance level* is 0.027. Differences in concretes are judged significant by the sign test under Conditions B but were non-significant under Conditions A. This illustrates the gain in precision through pairing with these data, and inspection of the data shows large batch-to-batch differences.

DISCUSSION

In the theory and examples of the preceding sections we have considered tests analogous to t tests on the equality of population means. If it is desired to test that the mean of the X-population is b units larger than the mean of the Y-population, it is only necessary to add b to each Y-observation and proceed as above. Thus the rank tests are more general than we have perhaps implied. Further, the sign test may be used as a rank analogue of the one-sample t test and we now add this note for completeness.

The t statistic is used to test the hypothesis that a single sample, $X_1, \ldots, X_N$, came from a population with a specified mean. If the population is normal, this is equivalent to a specification of the median. Suppose a null hypothesis states that the median of the population has the value, C. The differences, $X_1 - C, \ldots, X_N - C$, have equal probabilities, $p = \frac{1}{2}$, of being positive or negative. Then this array of differences may be used to generate a set of positive and negative signs similar to those shown in the last line of Table II. The binomial test is used in this case in exactly the same way as illustrated in the example for paired differences.

We now see that the sign test is used as an alternative to the one-sample t test for single-sample and paired-sample problems while the two-sample t test may be replaced by the Wilcoxon test or the Mann and Whitney test. Rank analogues to t tests then exist and may be used whenever a rough-and-ready method is sufficient or when the validity of a t test is in doubt due to the nature of the population or populations sampled.

In the second part of this paper, we continue with some rank analogues to the F tests used in the analysis of variance.

*The t-test on paired differences on the original observations with nine degrees of freedom has a significance level, 0.068.

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Book Reviews

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QUALITY CONTROL, Norbert L. Enrick, The Industrial Press, 148 Lafayette St., New York 13, N. Y., 2nd edition, 1954, 181 pages. $4.00. Review by E. C. Yehle, University of Michigan, Ann Arbor, Mich.

Part I of this book first presents the routines of selecting lot-by-lot sequential inspection plans and of constructing variables control charts based on specification limits. Following these chapters, the author discusses the subjects of tolerances and gaging and gives a case history of a quality control installation in a metal working plant. The section ends with an explanation of some of the theoretical aspects underlying sampling plans and control charts. Part II, which is new to this 2nd edition, includes a discussion of the normal curve and of control charts not previously mentioned: namely, percent defective, acceptance control, and averages based on the process center line. A final chapter on analysis of variance introduces the reader to the idea that overall process variability can be analyzed into its various component sources.

QUALITY CONTROL is intended to be a "manual of practical procedure for shop and plant operation." As such, its simplified style, its presentation of practice first and theory

second, and its development of specific application as early as page 12 will appeal to the practical man in industry. Enrick also succeeds in putting across many ideas which inspectors are sure to appreciate seeing in print. For example, any thought that quality control sampling methods will eliminate all screening inspection is removed by the statement on page 2 that "screening is inevitable in the case of vital parts upon which the functioning of an entire assembly depends, and also where a process normally turns out a high percentage of defective product." Hearty approval will also be given this comment on page 61: "Interchangeable manufacturing depends not only upon tolerances but also upon precise and efficient measuring or gaging devices for checking whatever tolerances have been established."

A simplified presentation of a technical subject, however, involves compromises which, while they cannot be condemned with certainty, are yet open to question. They are perhaps most questionable for the person who later will wish to read elsewhere on the subject of quality control or who must reconcile the methods currently in use in his own company with those suggested by the author. In this connection, one who recommends Enrick's book should realize that:

1. The reader's first introduction to control limits will be in terms of modified limits based on product specifications.
2. Standard control chart factors are not used, partly because 2-σ rather than 3-σ limits are employed.
3. The emphasis of the book is on "how" not "why."

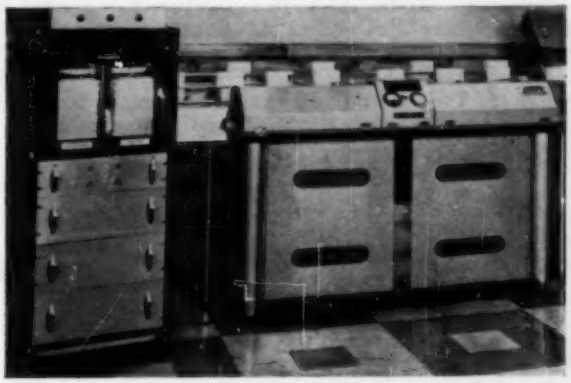
Perhaps the greatest lack of clarity appears in connection with the meaning of "Allowable Percent Defective" which, as in the first edition, sometimes seems to mean Acceptable Quality Level and sometimes Average Outgoing Quality Level. According to the text, the allowable percentage is chosen on the basis of economic considerations. A sampling plan which will guarantee protection against higher percentages defective then can be chosen, provided that the normal percentage produced does not exceed the allowable limit. The idea of "normal" here is not that of a process average, but rather an upper limit which will not normally be exceeded.

Since the sampling tables require that "all rejected lots will be screened" the notion of A.O.Q.L. is clearly implied. However, the interpretation that the overall percent defective will be held *at* the allowable limit, regardless of the fact that the incoming quality will probably be *below* that limit, is a misstatement. The glossary in the final chapter adds to the confusion by identifying Allowable Percent Defective with Acceptable Quality Level.

There are relatively few typographical errors in the book, but an unfortunate mistake does appear on page 155 in computing the standard error of a percentage. The answer obtained is 0.12 percent, instead of the correct value 1.2 percent, and this carries through to the point where a chart is shown to be badly out-of-control when in fact it is entirely within control.

QUALITY CONTROL may well assist industrial people in starting a quality control program of their own. It will not equally well fulfill the needs of the college student.

Editor's note: A review of the first edition of this book by Professor



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Niles Barnard, Chairman, Dept. of Mech. Eng., Univ. of Nebraska was carried in this Journal, Vol. V, No. 4, Jan. 1949, pp. 27-28.

INTRODUCTION TO MATHEMATICAL STATISTICS, Second Edition, Paul G. Hoel; John Wiley and Sons, Inc., New York, 1954. 331 + xi pages. $5.00. Reviewed by Leo A. Aroian, Hughes Aircraft Company.

The second edition of this pioneering text is a great improvement over the first edition. Its high rank among texts requiring only calculus is easily maintained because of its clarity and simplicity. While thoroughly modern, the author is careful in his selection of material, achieving a good balance between theory and applications. The second chapter provides an early introduction to the Neyman-Pearson theory of testing hypotheses and to maximum likelihood for estimation. These two ideas provide the unifying force of the book. This chapter is preceded by an expanded chapter on probability and the idea of a distribution function. Other revisions include expansion of the material on regression and correlation; unification of the applications of the χ^2 distribution; a more thorough treatment of confidence limits, analysis of variance, non-parametric methods and finally a much longer list of interesting exercises and problems. While the author does not avoid mathematics where it is needed, he is very skillful in making proofs as simple as possible.

An improvement for future revision might be a treatment of consistency and efficiency, although the notion of an unbiased statistic is discussed. Only one serious misprint was noted. On page 157, the equation on the second line should read

$$\rho(1-\rho^2) + r(1+\rho^2)\left(\frac{1-\rho^2}{1-\rho r}\right) = 2\rho\left(\frac{1-\rho^2}{1-\rho r}\right)$$

in place of

$$\rho(1-\rho^2) + (1+\rho^2)\left(\frac{1-\rho^2}{1-\rho r}\right) = 2\rho\left(\frac{1-\rho^2}{1-\rho r}\right).$$

As a basic reference book and text in mathematical statistics, Hoel's revised book is highly recommended for those in quality control and in other fields.

Practical Aids

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The Use of Ranges in Comparing Variabilities

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The standard procedure for comparing variabilities (that appears in the usual statistics text) is the "variance ratio test" (ordinary F-test). This test requires the squaring and summing of individual measurements and may involve considerable work. For certain kinds of problems, recent developments in statistical theory now permit the substitution of a *Range-Square Ratio Test* (F_R-test) in place of a variance ratio test, with all the savings to be gained in using ranges.

Consider for example the data of Table I. Here are listed the ranges of samples ($n = 5$) from two production runs. In both cases, it can be shown that production is in control with respect to range. In this particular case, however, management was interested in whether the second production run had less *variability* than the first. This type of question may be answered directly by computing the Range-Square Ratio from the average ranges, $\overline{R}_1$ and $\overline{R}_2$, of the two runs

$$F_R = \frac{[\overline{R}_1/(d_2^*)_1]^2}{[\overline{R}_2/(d_2^*)_2]^2} \qquad (1)$$

where the values of d_2^* (read "d-two-star") are an adjusted d_2 factor given directly by Table III in the Appendix.

If the sub-sample sizes are represented by n_1 and n_2 and the number of sub-samples in each group by k_1 and k_2, and if $n_1 = n_2$ and $k_1 = k_2$, we have simply

$$F_R = \overline{R}_1^2/\overline{R}_2^2 \qquad (1a)$$

When we compare the variabilities of two processes by the usual variance ratio test, we form the F-ratio by dividing the larger sample variance (s_1^2) by the smaller one (s_2^2); i.e., we take

$$F = s_1^2/s_2^2$$

Then to determine whether the two sample variances are significantly different, we enter a table of critical values of the F-ratio corresponding to ν_1 and ν_2 degrees of freedom (d.f.). The method of determining ν_1 and ν_2 is described in statistics texts that discuss analysis of variance. For example, if s_1^2 is the average within-group sample variance from k_1 groups of n_1 each, then

$$\nu_1 = k_1\,(n_1 - 1).$$

Similarly, if s_2^2 is the average within group sample variance derived from an independent set of k_2 groups of n_2 each, then

$$\nu_2 = k_2\,(n_2 - 1).$$

In the method of this paper, we form the F_R-ratio and enter the *ordinary F-table* with the degrees of freedom ν_1 and ν_2 as given in Table III. A casual inspection

TABLE I—Ranges of Samples of 5 Blocks when measuring widths of Slot of Terminal Block ($n = 5$)
(Adapted from E. L. Grant, *Statistical Quality Control* 2nd Rev. Ed., pp. 150, 154.)

First Production Run	Second Production Run
51 25	47 27
51 36	31 17
36 36	32 38
74 38	22 35
50 20	7 17
20 13	32 26
38 27	21 14
16	18 24
$\Sigma = 534$	$\Sigma = 408$
$\bar{R}_1 = 35.6$	$\bar{R}_2 = 25.5$
$UCL = R_1D_4 = 75.1$	$UCL = \bar{R}_2D_4 = 53.8$

will indicate that the values given in Table III are approximately ten percent less than the $k(n - 1)$ d.f. which would be used in the ordinary variance ratio test.

Example 1. The procedure may be described by carrying out the computations with reference to the data of Table I. Here, for both production runs, $n_1 = n_2 = 5$; also $k_1 = 15$ and $k_2 = 16$. By entering Table III, we find the following values of d_2^* and ν

First Production Run:

$$k_1 = 15,\ n_1 = 5,\ \nu_1 = 54.6 \text{ and } d_2^* = 2.34$$

Second Production Run:

$$k_2 = 16,\ n_2 = 5,\ \nu_2 = 58.2 \text{ and } d_2^* = 2.34.$$

Thus

$$F_R = \frac{(35.6)^2 / (2.34)^2}{(25.5)^2 / (2.34)^2} = 1.96.$$

To determine whether this F_R indicates a significant difference at the 0.05 level, we note whether it exceeds the 0.025 point of an ordinary F-table* for the corresponding degrees of freedom; i.e., whether it exceeds $F_{.025} = 1.6$. Since it does, it may be concluded that the variability of the process has actually been reduced in the second run.

The basic assumptions underlying the Range-Square Ratio Test are similar to those underlying the variance ratio test. They are:

(1) that the production runs are both in control with respect to variability (in general, that variations within the subsample of each group are the results of a single system of chance forces.)

(2) that variation within subsamples is normally distributed; and

(3) that the larger adjusted square-range is made the numerator of the F_R-ratio.

For the Range-Square Ratio Test we have the following additional assumption:

(4) that the distribution of the range can be reasonably well approximated by a χ-distribution.

Example 2. Another example of the use of the F_R-test relates to the testing for homogeneity of variance in two methods of a chemical analysis. The data of Table III pertain to the ranges of three determinations of a chemical characteristic by each of four analysts on each of four samples. In the first set, determinations are made by Method A, and in the second by Method B. The question is whether the experimental variability of the second method is an improvement over the first. It is assumed that the experimental variability is independent of analyst and sample, so that the ranges can be averaged for each set. Here we have:

$$\bar{R}_1 = 1.37 \qquad \bar{R}_2 = 0.75$$
$$n_1 = 3 \qquad n_2 = 3$$
$$k_1 = 16 \qquad k_2 = 16$$

and from Table III

$$\nu_1 = 29.3 \qquad \nu_2 = 29.3$$

(Note: $k(n - 1) = 16 \times 2 = 32$; 90 percent of 32 = 29, approximately.) Then,

$$F_R = \frac{(1.37)^2}{(0.75)^2} = 3.4.$$

Let us decide in this case to run a one-sided test at the 0.05 level. We then take $F_{.05}$ as our critical value. For the given ν_1 and ν_2 we have from the F-table that

TABLE II—Ranges from Chemical Determinations ($n = 3$)
(These data were kindly supplied by Prof. Ellis R. Ott.)

		Analysts I	II	III	IV
Method A	1	2.0	3.1	0	1.5
Samples	2	0.5	2.0	2.5	0.3
	3	1.5	1.9	1.5	0.8
	4	2.5	0.5	1.0	0.3
		$\bar{R}_1 = 1.37$			
		I	II	III	IV
Method B	1	0.5	1.3	1.0	1.0
Samples	2	0.5	1.1	0	0.9
	3	1.0	0.8	0.5	0.3
	4	1.0	0.7	1.0	0.3
		$\bar{R}_2 = 0.75$			
		$F_R = \frac{(\bar{R}_1)^2}{(\bar{R}_2)^2} = 3.4$			

$F_{.05}$ is about 1.87. Since our F_R is in excess of 1.87, we conclude that the variability of the second method B is an improvement over the variability of method A.

In general, whenever the variabilities that are to be compared are estimated from the average ranges of two independent sets of samples and when the assumptions listed above are valid, the Range-Square Ratio Test can be applied.

Appendix

The reader may be puzzled by the use of d_2^* instead of the ordinary d_2 factor. The facts are that we need to divide $\bar{R}$ by d_2^* in order that $(\bar{R}/d_2^*)^2$ will be approximately distributed as $\frac{\chi^2 \sigma'^2}{\nu}$ with ν degrees of freedom so that in turn when $\sigma_1' = \sigma_2'$ the ratio of two such quantities will be distributed as F.

But the reader may remark: "I thought $\bar{R}/d_2$ gives an unbiased estimate of σ'. What does $\bar{R}/d_2^*$ give? Is it a better estimate of σ'?" The answer to this query is that $(\bar{R}/d_2^*)^2$ gives an unbiased estimate of σ'^2. Thus if we wish to estimate σ' we would use $\bar{R}/d_2$, but to estimate σ'^2 we would use $(\bar{R}/d_2^*)^2$. The quantity $(\bar{R}/d_2)^2$ does not give an unibased estimate of σ'^2 nor does $\bar{R}/d_2^*$ give an unbiased estimate of σ'.

* If the 0.05 point is used in this instance, the test is being run at a 0.10 level. The discussion assumes that the management is interested in detecting a change in either direction. If a one tail test is to be run at an 0.05 level, the $F_{.05}$ point should be used.

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"But I note that d_2^* approaches d_2 as the number of samples k is increased. How do you explain that?" continues the reader. The answer follows from the mathematical properties of the χ^2 and χ distributions. The mean of $\frac{\chi^2\sigma'^2}{\nu}$ is σ'^2 whereas the mean of $\frac{\chi\sigma'}{\sqrt{\nu}}$ is $\sigma'\left(1-\frac{1}{4\nu}+\frac{1}{32\nu^2}+\frac{5}{128\nu^3}+\ldots\right)$.

Now when we treat $(\overline{R}/d_2^*)^2$ as distributed as $\frac{\chi^2\,\sigma'^2}{\nu}$ with ν degrees of freedom, the larger the number of samples (k) averaged to get $\overline{R}$, the larger will be the degrees of freedom ν and hence the closer the mean of $\sqrt{(\overline{R}/d_2^*)^2}$, which is approximately the mean of $\frac{\chi\,\sigma'}{\sqrt{\nu}}$, will be to σ'. But the mean of $\overline{R}/d_2$ is σ' (that is what is meant by $\overline{R}/d_2$ being an unbiased estimate of σ'). Hence, as k increases, ν increases and d_2^* approaches d_2.

The idea that the distribution of $\overline{R}$ could be approximated by a χ distribution was suggested by P. B. Patnaik in 1950, and in the same article he suggested that the square of the ratio of two average ranges was the equivalent of an F variable. L. A. Seder and D. Cowan made use of these ideas in their paper on the SPAN Plan presented at the 1953 ASQC Convention. (The symbol d_2^* is used in the mathematical appendix to the SPAN Plan that is expected to be published shortly with the main article in IQC.) Ellis R. Ott, who himself had been using the Range-Square Ratio Test for some time, persuaded the author to write up the procedure for presentation in this Practical Aids Section.

Selected References

(1) Cox, D. R., "The Use of the Range in Sequential Analysis," *Journal of the Royal Statistical Society*, B, Vol. 11 (1949) pp. 101-114.

Cox suggests that the distribution of the range can be approximated by a χ^2 distribution. Patnaik's suggestion (Ref. 5) that the range can be approximated by a χ distribution was adopted in this article since its use fitted better with existing quality control practice.

(2) David, H. A., "Further Applications of Range to the Analysis of Variance," *Biometrika*, Vol. 38, (1951) pp. 393-407.

(3) Hartley, H. O., "The Use of Range in Analysis of Variance," *Biometrika*, Vol. 37, (1950) pp. 271-280.

(4) Link, R. F., "The Sampling Distribution of the Ratio of Two Ranges from Independent Samples," *Annals of Mathematical Statistics*, Vol. 21, (1950) pp. 112-116.

This article may be of interest when single ranges are being compared.

(5) Patnaik, P. B., "The Use of Mean Range as an Estimator of Variance in Statistical Tests," *Biometrika*, Vol. 37, (1950) pp. 78-87.

This is the source of the suggestion that the distribution of the range can be approximated by a χ distribution.

(6) Pearson, E. S., "Comparison of Two Approximations to the Distribution of the Range in Small Samples from Normal Populations," *Biometrika*, Vol. 39, (1952) pp. 130-136.

(7) Pearson, E. S. and Hartley, H. O., *Biometrika Tables for Statisticians*, New York: Cambridge University Press, 1954.

This contains all the latest tables for the use of the range in statistical tests.

(8) Seder, L. A. and Cowan, D., "The SPAN Plan—A New Method of Process Capability Analysis," *Conference Papers*, ASQC Seventh Annual Convention, Philadelphia, 1953, pp. 576-599.

TABLE III—Values of Adjusted d_2 factor (d_2^*) and Degrees of Freedom ν To be used with Estimates of σ' based on k Independent Sample Ranges of n Cases Each

(An extention of Table by H. A. David—See References 2 and 7.)

Unbiased Estimate of $\sigma'^2 = (\overline{R}/d_2^*)^2$

Unbiased Estimate of $\sigma' = \overline{R}/d_2$

k	n = 2		n = 3		n = 4		n = 5		n = 6		n = 7	
	ν	d_2^*	ν	d_2^*	ν	d_2^*	ν	d_2^*	ν	d_2^*	ν	d_2^*
1	1.0	1.41	2.0	1.91	2.9	2.24	3.8	2.48	4.7	2.67	5.5	2.83
2	1.9	1.28	3.8	1.81	5.7	2.15	7.5	2.40	9.2	2.60	10.8	2.77
3	2.8	1.23	5.7	1.77	8.4	2.12	11.1	2.38	13.6	2.58	16.0	2.75
4	3.7	1.21	7.5	1.75	11.2	2.11	14.7	2.37	18.1	2.57	21.3	2.74
5	4.6	1.19	9.3	1.74	13.9	2.10	18.4	2.36	22.6	2.56	26.6	2.73
6	5.5	1.18	11.1	1.73	16.6	2.09	22.0	2.35	27.1	2.56	31.8	2.73
7	6.4	1.17	12.9	1.73	19.4	2.09	25.6	2.35	31.5	2.55	37.1	2.72
8	7.2	1.17	14.8	1.72	22.1	2.08	29.3	2.35	36.0	2.55	42.4	2.72
9	8.1	1.16	16.6	1.72	24.8	2.08	32.9	2.34	40.5	2.55	47.7	2.72
10	9.0	1.16	18.4	1.72	27.6	2.08	36.5	2.34	44.9	2.55	52.9	2.72
11	9.9	1.16	20.2	1.71	30.3	2.08	40 1	2.34	49.4	2 55	58.2	2.72
12	10.8	1.15	22.0	1.71	33.0	2.07	43.7	2.34	53.9	2.55	63.5	2.72
13	11.6	1.15	23.9	1.71	35 7	2.07	47.4	2.34	58.4	2 55	68.8	2.71
14	12.5	1.15	25 7	1.71	38.5	2.07	51.0	2.34	62.8	2.54	74.0	2.71
15	13.4	1.15	27.5	1.71	41.2	2.07	54.6	2.34	67.3	2.54	79.3	2.71
16	14.3	1.15	29.3	1.71	43.9	2.07	58.2	2.34	71.8	2.54	84.6	2.71
17	15.2	1.15	31.1	1.71	46.7	2.07	61.8	2.34	76.2	2.54	89.8	2.71
18	16.0	1.15	33 0	1.71	49.4	2.07	65.5	2.33	80.7	2.54	95.1	2.71
19	16.9	1.14	34.8	1.70	52.2	2.07	69.1	2.33	85.2	2.54	100.4	2.71
20	17.8	1.14	36.6	1.70	54.9	2.07	72.7	2.33	89.7	2.54	105.7	2.71
25	22.2	1.14	45.7	1.70	68.5	2.07						
30	26.6	1.14	54.8	1.70								
50	44.2	1.13										
d_2		1.128		1.6926		2.0588		2.3258		2 5344		2.7044

Bibliography

JOSEPH MOVSHIN, *Editor*
Assisted by the Editorial Committee, St. Louis Section, ASQC

On matters concerning the Bibliography Department, send correspondence, suggestions, and contributions to:
Joseph Movshin
9220 Old Bonhomme Road
St. Louis 24, Mo.

APPLICATION—CHEMICAL INDUSTRY

CONTROLLING QUALITY OF COMPOUNDING LABORATORY RESULTS, by B. J. A. Martin
(Institute of Rubber Industry—Transactions, p. 157)

This is an example of the use of simple Statistical Quality Control charts to control variability. In this individual instance in the rubber industry, mixing, vulcanizing, testing, and computing, contribute to the overall variability. Some discussion and justification for using non-random samples is included.

APPLICATION—MEDICAL & DRUG INDUSTRY

EVALUATION OF SOLUTION QUALITY — STATISTICAL APPROACH, by John H. Halsey
(Journal of the American Pharmaceutical Association, Scientific Edition—v. XLIII, n. 11, Nov. 1954, p. 674)

This paper describes a method of evaluating mechanical impurities in solutions that are found by visual examination under strong lights. The establishment of the standard and a ranking procedure are described. The evaluation of the ranking method and the theoretical background for the test and ranking method are described. Control chart and correlation techniques are used.

APPLICATION—METAL WORKING

A FOUR STEP PLAN FOR CONTROLLING QUALITY IN PROCESS, by Michael P. Agresta
(SQC Engineer, Pesco Products Div. Borg-Warner Corp., Cleveland, Ohio)
(Tooling and Production—v. XX, n. 10, Jan. 1955, p. 69)

Four basic steps necessary for an overall program for in-process quality control is presented. These steps are:

1. Maintaining the History Records on Parts
2. Inspection and Recording of Data
3. Plotting and Analysis of Data
4. Follow Through for Corrective Action

Many of the charts, forms, and records kept are illustrated. The importance of follow up to management is stressed.

ANALYSIS OF VARIANCE

NEW EXPERIMENTAL DESIGNS FOR PAIRED OBSERVATIONS, by W. J. Youden and William S. Connor
(Journal of Research of the National Bureau of Standards—v. 53, n. 3, Sept. 1954, p. 191)

In experimental sets, where observations occur in pairs, an exceedingly large number of values must usually be dealt with, even for a moderate number of observations. This paper describes an experimental design where subsets of pairs can be used. Considerations in selecting the subsets and the arithmetic involved in the calculations are described. Tabular representations and illustrations of this method are given.

ENGINEERING & EXPERIMENTS

SENSITIVITY — A CRITERION FOR THE COMPARISON OF METHODS OF TEST, by J. Mandel and R. D. Stiehler
(Journal of the Research of the National Bureau of Standards—v. 53, n. 3, Sept. 1954, p. 155)

In certain cases of testing, accuracy and precision as related to a standard cannot be applied. For such cases, a quantitative measure of a test method—"Sensitivity"—is presented. In this case "Sensitivity" is presented as a ratio. A statistical test of significance for the ratio between sensitivities of alternate methods is also presented. The theory of this test is developed in some detail and examples of its use are given.

STATISTICAL STUDY OF PROPERTIES PROVES AID IN PART DESIGN, by J. J. Lombardo and M. L. Parrish
(The Iron Age—v. 174, n. 25, Dec. 16, 1954, p. 120)

This article describes some of the elementary statistics and some of the special techniques that can be applied to the testing of materials for new designs. The advantages of the statistical approach are strongly stressed.

MANAGEMENT & PERSONNEL —GENERAL

PRODUCTION SHOULD SUPERVISE QUALITY CONTROL, by D. R. King
(American Machinist—v. 98, n. 15, July 19, 1954, p. 128)

In this article, the author presents the consideration that quality control should be controlled by the production department. As it is important for quality control to achieve immediate action on the basis of findings through product inspection, direct control by production is presented as necessary. Some of the basic considerations in quality control as related to the supervision of production are discussed.

IS QUALITY YOUR HEADACHE? by Robert Newcomb and Marg Sammons (Management Consultants)
(Mill & Factory—v. 55, n. 2, Aug. 1954, p. 75)

This article describes a quality improvement suggestion contest as a means of getting employee interest and assistance in correcting quality problems.

Selected references in the Bibliography of *Industrial Quality Control* are obtained from the following sources:

The International Statistical Institute, *International Journal of Abstracts on Statistical Methods in Industry.*

The Chemical Division, ASQC.

The Statistical Committee, TAPPI.

INDUSTRIAL MANAGEMENT

SCHEDULING: MATH SYSTEM PAYS OFF, by T. M. Rohan (The Iron Age—v. 174, n. 25, Dec. 16, 1954, p. 76)

This article describes the advantages of "Mathematical Programming" to production scheduling at the Mueller Brass Co.

Considerations in developing such programming are discussed.

MISCELLANEOUS

STATISTICAL COMPUTERS AS APPLIED TO INDUSTRIAL CONTROL, by P. Huggins (British Institute of Radio Engineers—Journal—v. 14, n. 7, July 1954, p. 309)

Statistical controls of continuous industrial processes generally use a "human" controller. Examples of such situations are described. The possibility of automatizing such control is discussed and advantages and disadvantages noted. Some of the electronic circuit techniques necessary and the proper functioning of such an electronic controller are discussed.

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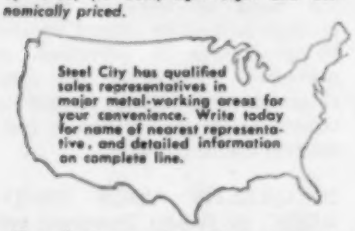

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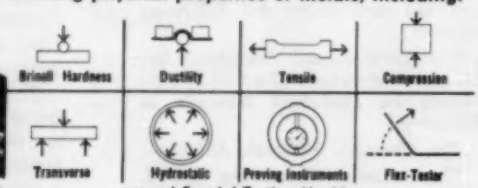

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THEORY AND APPLICATION—GENERAL

EXTREME-VALUE METHODS FOR ENGINEERING PROBLEMS

(The Technical News Bulletin of the National Bureau of Standards, Feb. 1954)

This article discusses new statistical methods for extreme values in engineering problems. Basically, the normal distribution curve does not usually supply information required to predict extreme conditions. Certain skewed distributions, however, do tend to have this ability. Special extreme-value probability paper for the extreme-value distribution is used to predict probability associated with particular occurrences.

STATISTICS

APPROXIMATE DISTRIBUTION OF THE RANGE IN THE NEIGHBORHOOD OF LOW PERCENTAGE POINTS, by M. Belz and R. Hooke

(Journal American Statistical Association—v. 49, Sept. 1954)

BOUNDS ON A DISTRIBUTION FUNCTION THAT ARE FUNCTIONS OF MOMENTS TO ORDER FOUR, by Marvin Zelen

(Journal of Research of the National Bureau of Standards—v. 53, n. 6, Dec. 1954, p. 377)

COMBINING INDEPENDENT TESTS OF SIGNIFICANCE, by A. Birnbaum

(Journal American Statistical Association—v. 49, Sept. 1954, p. 49)

MINIMUM LIFE IN FATIGUE, by A. M. Freudenthal and E. J. Gumbel

(Journal American Statistical Association—v. 49, Sept. 1954, p. 575)

SUFFICIENCY AND STATISTICAL DECISION FUNCTIONS, by R. R. Bahadur

(Annals of Mathematical Statistics—v. 25, Sept. 1954)

OPERATIONS RESEARCH

MATHEMATICS SPOTS HIDDEN PROFITS, by Nyles V. Reinfeld (Executive Services, Cleveland)

(Steel—v. 135, n. 24, Dec. 13, 1954, p. 118)

This article describes an application of linear programming to production scheduling in a tube mill. The advantages are noted and samples of a schedule are illustrated. Details of the development of the schedule are not given.

DECISION THEORY: OPERATIONS RESEARCH IN MANAGEMENT, by Dr. George E. Kimball (Professor Chemistry, Columbia University)
(Advanced Management—v. XIX, n. 12, Dec. 1954, p. 5)

Dr. Kimball presents basic considerations in decision making. Discussed in some detail are the kinds of decisions and the basic mathematical models for certain programs involving decisions. The application of simple probability to decision theory is illustrated.

What's New?

ROY A. WYLIE, *Editor*

News releases describing new products and literature should be sent to:
George R. Foster, Mng. Ed.
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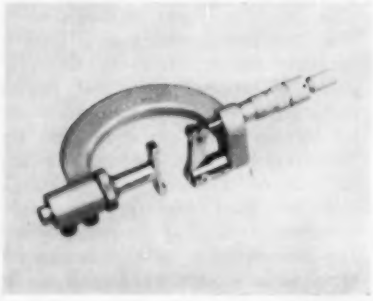
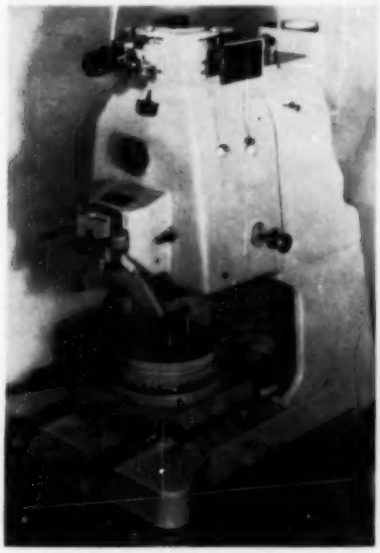
Milwaukee 3, Wis.



The **Taper Micrometer Corp.**, 100 Grove St., Worcester, Mass., is now producing a direct reading Taper Micrometer for measuring external taper. This device eliminates the necessity for removing the work piece from the machine and setting up a sine bar, gage blocks and a surface gage or other expensive measuring equipment. It measures taper while the piece is still on the machine in the same manner as the diameter of a straight bar can be measured with an ordinary micrometer. Readings can be made in tenths and the necessity for re-centering the work piece in the machine is eliminated.

★ ★ ★

William J. Hacker & Company, Inc., 82 Beaver St., New York 5, N. Y., are now marketing a newly developed Interferometer. It is adapted for testing the planeness of polished surfaces by means of Fizeau fringes, for determination of the radius of curvature of slightly spherical surfaces by means of Newton rings, for determination of the wedge angle of slightly wedged transparent plates by means of Fizeau fringes as well as for plane parallelity investigations on transparent plates by means of Haidinger rings. It may also be used for comparison measurements on end gages. The optical system reproduces interference images with



great sharpness and freedom from distortion and reflection. Surfaces up to 5½" can be tested for planeness. Measuring radii of curvature up to a radius of curvature of 60 miles is possible. Gage blocks up to 5½" in length may be checked. Interferometric measurements of many precision parts are possible.

★ ★ ★

George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y., has recently introduced a simplified, newly designed Length Measuring Machine for external and internal measurements having a range up to 120". Reading is accomplished by means of a steel scale and extra large vernier to 1/1000" and 1/50 MM. The vernier is 2.450" long as compared to the ⅝" vernier commonly used. Both inch and millimeter verniers are adjustable. The machine may be used as a master or check for setting large Micrometers, Snap Gages, End Measuring Rods, Pin Gages, Standard Bars, etc. Scale and gaging members are mounted on a cast iron base and two models are available, an 80" size weighing 300 pounds and a 120" size weighing 400 pounds. An illustrated circular may be obtained by writing to George Scherr Company, Inc.

★ ★ ★

Deltron, Inc., 2905 N. Leithgow St., Philadelphia, Pa., has recently announced a new Deltron RC Bridge. This is a low cost, completely self-contained, portable, resistance capacitance bridge for making measurements on capacitors from 10 μμf to 50 μfd and resistors from 10 ohms to 50 megohms and can also be used for making continuity measurements on circuits, coils and transformers. It is constructed with one-percent precision resistors and two-percent precision capacitors. The unit detects paper, mica, electrolytic and air capacitor faults including open and short circuits, high and low capacity, and high power factor. It has a direct reading scale and the power factor of electrolytic capacitors is indicated by means of a visual eye detector tube. All capacitance and resistance measurements are

read on a single scale in six overlapping ranges using a selector switch.

★ ★ ★

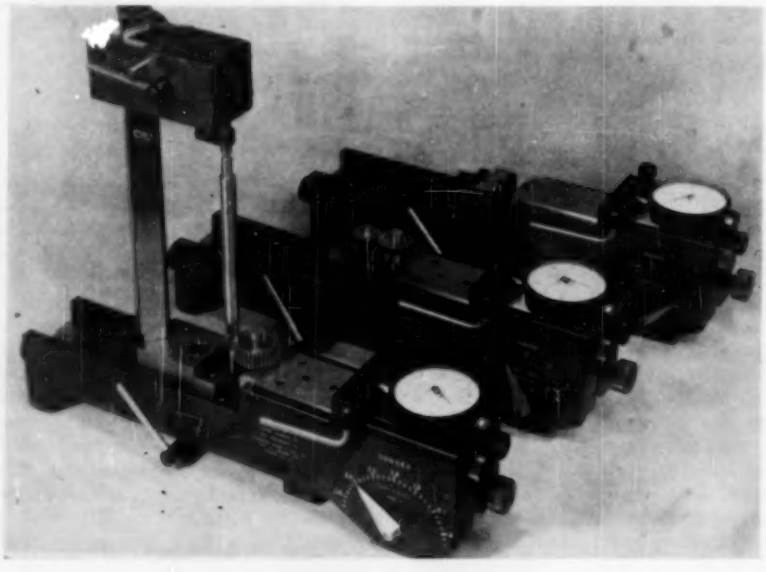
The Cincinnati Div., Bendix Aviation Corp., 203 W. Third St., Cincinnati 2, Ohio, are making available several models and attachments for the standard Bendix Ultra-Viscoson electronic viscometer. This device has been successfully used in a wide variety of applications requiring close control of viscosity of liquids during processing. In one application the viscosity changes during the polymerization of phenolic laminating resins is continuously recorded. Six kettles may be monitored simultaneously and an alarm is provided to signal when the viscosity end points are reached. In other applications the viscometer has controlled the automatic addition of solvent to lacquer solutions to maintain optimum viscosity. Lacquer coatings used in hardware, leather goods and lamp manufacture can be maintained at uniform concentration in dip tanks, resulting in savings in solvent and in uniform product coating quality. In multicolor gravure presses this device controls the lacquer coating of printed cartons as well as the color shade of the gravure inks. The viscosity sensing probe is hermetically sealed and contains an explosion-proof junction box. It is mounted by means of standard pipe fittings directly into dip tanks or reservoirs. The probe is connected to an electronic computer which translates the damping effect of liquids on the rugged vibrating reed of the probe into viscosity information.

★ ★ ★

Precision Sales & Mfg. Co., 7947 S. Harvard Ave., Chicago 20, Ill., are exclusive sales agents for the VARI-ROLL Variable Center Distance Gear Checking Fixture. The VARI-ROLL is a precision gear checking device designed for the fine pitch gear industry. It incorporates such features as an adjustable measuring pressure gaging head that may be pre-set to pressures recommended in American Standard A.S.A., B.6 11-1951, versatile "Vee" mountings for gears and master gear arbors, extreme sensitivity and versatility through the use of standardized and special interchangeable attachments to check a wide range of sizes and types of gears that in the past have required special single purpose fixtures. Parallelism and in-plane accuracies of the gear and master gear arbor locating "Vees" and centers are well within 0.0001" per inch insuring full face contact of the gear to the master gear. Available also are VARI-ROLL Ultra-accuracy master gears for use with the VARI-ROLL Gear Checker. These gears are available to 220 D.P. and are normally run to a maximum total Composite error of 0.00015 —0.002".

★ ★ ★

General Electric Co., X-Ray Div., 4855 Electric Ave., Milwaukee 1, Wis., has announced a new type of portable industrial x-ray unit capable of producing a 360 degree radiation sweep. Many products can be set up in a circle around the "business head" of the machine and all can be x-rayed with a single exposure, thus reducing radiographic operation time. If desired, the unit can also operate as a conventional type with a limited angelcone of radiation. The unit may be placed inside a pipe or pressure vessel and used to take "inside out" x-ray views. The advantage of this technique is that it confines the radiation within an enclosed area, increasing the protection to personnel against radiation exposure, and also that it permits the making of a complete circumferential weld radiograph with a single exposure. The new machine consists of a tank to house the x-ray tube and energizing transformers, linked to control and power source by inter-connecting cables.

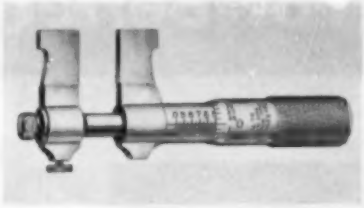


The tube head weighs less than 185 pounds and has a diameter of 10½" and a length of 42". The control unit measures 18" by 18" by 14" and weighs 145 pounds. It can be operated at x-ray tube voltages from 45,000 to 175,000 volts and contains many features for the operator's convenience and automatic safeguards against improper operation.

★ ★ ★

A new type Plunjet Adjustable Airsnap Gage for connection to a flow type Precisionaire has been announced by the **Sheffield Corp.**, Dayton 1, Ohio. Twelve models are available, providing a graduated size range from 0 to 12" in one-inch increments. The Plunjet gaging cartridge is interchangeable, providing a gaging range from 0.001" to 0.080" and amplifications from 62.5 to 5,000 to 1. Sheffield dial indicator snap gages now in use can be converted into Plunjet Airsnaps by substituting an inexpensive adaptor and the proper Plunjet for the dial indicator. Gaging pressure is sufficient for positive alignment of the gaging anvils on the workpiece but can be lightened for gaging thin-walled parts.

★ ★ ★



The **L. S. Starrett Co.**, Athol, Mass., has developed a new inside micrometer Caliper combining the convenience and quick reading features of the micrometer with Vernier caliper style jaws in a tool that is compact and easy to use around precision work. The Inside Micrometer Caliper has a range of one inch to two inches by thousandths of an inch. The jaws are hardened and ground on a radius for more accurate "feel" without cramping. The micrometer is finished in a no-glare Satin Chrome Finish.

★ ★ ★

A wide range barium titanate accelerometer, representing a modified version of a National Bureau of Standards design, has just been announced by the **Gulton Mfg. Corp.** of Metuchen, N. J. This unit has a resonant frequency of 100 kc plus a useful frequency range of 10 to 40,000 cpc which provide currently the widest possible range of specifications for specialized military application. Sensitivity of Model A 450 is 0.25 mv/g, with a capacitance of 500 μμf or higher without cable. Maximum sensitivity is perpendicular to the mounting, and laterial sensitivity is less than ten percent. Temperature range is less than plus or minus ten percent variation in sensitivity from −40° C. to + 90° C. and acceleration range measures from 50 g to 50,000 g. Size of the unit is ½-inch hex by 1½ length at approximately 1¼ ounces. The mounting is ½ inch by 20 stud.

Management's Corner

J. M. JURAN, *Editor*

Correspondence is invited on potential contributions or problems appropriate for discussion in this department. Address your suggestions to:

J. M. Juran
Consulting Management Engineer
195 Beech Street
Tuckahoe, N. Y.

Two recent papers, each by an industrial executive, shed light on one of the most elusive of all quality control problems—the measure of quality control effectiveness.

Lenton[1] epitomizes it as follows:

"The effectiveness of any quality control department is directly reflected by the favorable change in the dollar figures which it is in a position to influence."

In more detail is Lenton's summary:

"(1) Quality control people are too often bound by their own control limits. Go on the alert, look around you, try to learn the language of your executive management, especially the planning and control functions connected with dollar activities.

"(2) Quality control shares in the making of your company's financial statement, whether it wishes to or not, and its function will, in a large measure, decide whether the statement is favorable or unfavorable.

"(3) Those engaged in quality control activities should learn accounting principles and practice. This will aid them to better understand the influence that they do create on their own company's financial statement.

"(4) Study your own financial statement. Ask yourself . . . . .'How have we contributed to the Asset side?' If you do not know, find out.

"(5) Go on the offensive! Ask your accounting department for assistance in obtaining current records. Some of the figures may shock you. If you take action, this is good. If you do not, somebody else *might!*

"(6) If you are a subsidiary and purchase from a co-subsidiary, set up uniform standards. Eliminate duplicate inspection. We do. It pays dividends.

"(7) You may have many plants in your organization. You will have but one consolidated financial statement—the annual report."

The idea of taking the initiative with the accounting department is well expounded by Day[2] in a quality control success story. Starting with the concept of a "hidden plant busily engaged in making defective merchandise we couldn't use," the company cut in half the losses they were studying. The measure of effectiveness was set up early in the game:

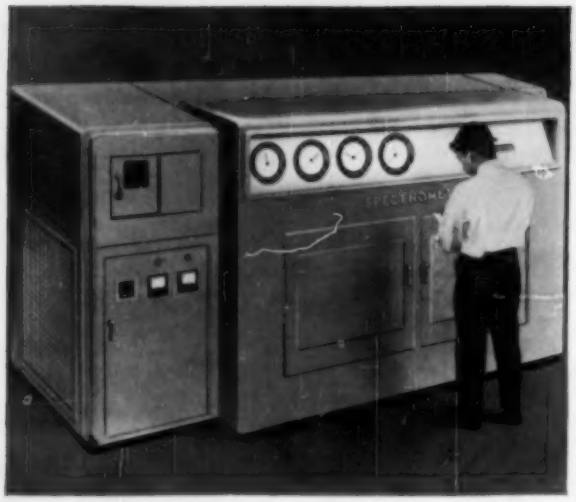
". . . . . these results are reported not by my organization (the Manufacturing Division) but by the factory cost accountants who are in the neutral and unbiased Financial Division. Early in the program we recognized that it was necessary to have a continuing and perpetual

1. J. Leslie Lenton (Works Manager, American Machine and Foundry Co.) "Quality Control Looks at the Financial Statement," ASQC Convention Proceedings 1954, pages 19-26.

2. Carl A. Day, Vice-President, Bausch and Lomb Optical Co., "Quality Control: Tool for the Manufacturing Executive," American Management Association Manufacturing Series #206, pages 15-21.

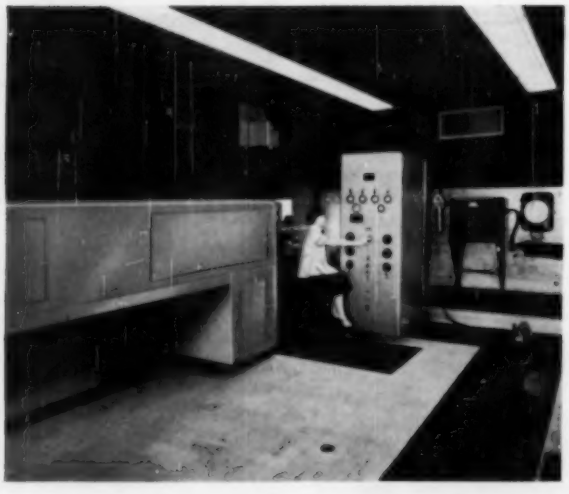
(Continued on page 30)

Four Of *The Best Reasons* For *Better Analysis*



SPECTROMET*

With Baird Associates Spectromet* quality control analysis is possible directly on the production floor. Indicator readings give constant control of the contents of the melt. Sealed optical and electrical compartments provide a built-in laboratory environment. This new instrument is designed for those who have a moderate work load involving no more than six elements in one matrix. Bulletin #42 (to be shown at the Pittsburgh Exposition, March 1, 1955)



3-M 20" SPECTROGRAPH

Baird Associates model 3-M Spectrograph, the first large grating instrument to be used commercially, offers many new refinements which increase its effectiveness. The instrument's modified Eagle mounting of a concave grating is the only one with the flexibility to permit use of the fourth or even higher spectrum. The range of the available spectrum is greater than twice that obtainable by any other commercial concave Spectrograph. The 20" camera gives the greatest wavelength coverage for a single exposure, WITH HIGH DISPERSION, of any standard instrument. Bulletin #32-C

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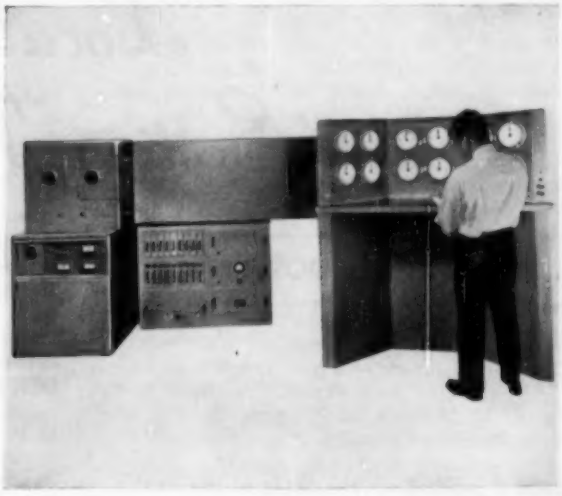
For unlimited value these instruments are the best that are currently available because they are built on VERIFIED PRINCIPLES. ♦ Therefore, they are the most reliable for rapid, large-volume sampling either in research or quality control analysis. They are widely used in the field of metals production and fabrication, in the inorganic and organic industrial chemicals and in related enterprises where the management knows that competitive advantages are to be gained by superior instrumentation.

DIRECT READERS

The new features of the 1955 Direct Readers give improved optical stability, more precise monitoring and increased flexibility in spectrum line selection. Both the standard production control type and the research instrument afford stability and precision far beyond the average and enable the quality control engineer to do his best work. The instrument will accommodate as many as sixty photomultipliers providing many variations for complex work loads. Bulletin #34-C



INFRARED

The Double Beam I R Recording Spectrophotometer for 1955 retains in its new design the outstanding features which made operation, control and maintenance rewardingly simple and easy. In addition, its advanced engineering now provides important slit programming for greater reproducibility, a continuous variable speed drive, a two-speed recorder for expanded wavelengths scale, provision for recording wave or linear wavelengths and many other features for greater versatility with speed and accuracy. Bulletin #33-C (to be shown at the Pittsburgh Analytical Exposition, March 1, 1955)

* Trade Mark

Baird Associates, Inc.

33 UNIVERSITY ROAD, CAMBRIDGE, MASS.

scoreboard. It was equally important that the division of the company responsible for reporting costs and financial matters perform this service as a regular function. The advantages of such an arrangement are obvious."

In the invariable experience of this department, the time inevitably comes when the Financial Division appraises quality control department effectiveness. In to many instances, this appraisal is part of a general management drive to reduce "overhead," an accounting classification which includes quality control departments. It is far better, in Mr. Day's words, to bring the accountants in "early in the program."

Local Section News

"...BUT NOT FORGOTTEN"

ALLENTOWN-BETHLEHEM A successful program in the establishment of a quality control functions was expertly outlined and explained by E. M. Schrock of Koppers Co. Inc. to members at the December meeting of this section.

BIRMINGHAM The Dec. 9 meeting of the section was held at the Redmont Hotel in Birmingham. "Quality Control at Westinghouse Electric Corp." was presented by E. H. Turnock, engineering manager in charge of engineering and quality control at both the Trafford, Pa. and Montevallo, Ala. electrode plants.

CHICAGO "The effectiveness of sampling plans, and clarification of the terms: quality characteristics, classification of defects, and vendor certification," was the subject of the December meeting of the elementary educational sessions held at the University of Illinois, Chicago Navy Pier.

CLEVELAND Two outstanding meetings highlighted the month of December for the Cleveland Section. At the regular monthly meeting on Dec. 3, an enlightening approach to the application of quality control techniques to fields other than manufacturing and inspection was visualized by a panel discussion. The panel consisted of members from sales, industrial engineering, accounting, purchasing, general office, and design engineering. The discussion emphasized the knowledge that QC analysis methods and techniques seem to be unlimited in any application.

The additional meeting, held with ASTE on Dec. 9, included the DoAll Co. exhibition "Civilization Through Tools" which was sponsored by ASTE. The array of tools which represents the thinking of man from his first use of a crude tools to present modern production tools is an exhibit of such magnitude and interest that it should be a "must" for any one having the opportunity of viewing it.

DAYTON The regular technical meeting for the month was held at the National Cash Register Co. on Dec. 9. Dr. Charles R. Hicks of Purdue University spoke on the "Fundamentals of Analysis of Variance." Following the meeting a social get-together with coffee and doughnuts was held in the National Cash Register cafeteria.

DENVER Prof. John F. Wagner, University of Colorado, addressed the Denver Section at its December meeting on the subject "Quality Incentive and the Cost of Inspections." Professor Wagner discussed the quality incentive techniques as used in the Subscription Fulfillment Department of Esquire-Coronet Inc. and also pointed out how the use of quality incentive "bonus" plans could maintain an economical balance between the cost of inspection and the financial gains realized through the reduction of clerical errors.

ERIE Ralph Wareham addressed the Dec. 7 meeting with the presentation "Managing Your Quality Control Program." This was a follow-up on the 1953 offering to the group.

HARRISBURG The "Technical Bull Session" of Jan. 5 resulted in an excellent discussion group and the attending group was so well pleased with the results that similar sessions will be scheduled regularly in the future.

INDIANAPOLIS The regular "chalk talk" session was held Dec. 14, in the World War Memorial Building. The first part of the meeting was conducted by Prof. Charles Hicks, Purdue University, who discussed "Operating Characteristic Curves Applied to the Average and Range Chart, p Chart and C Chart." The second portion of the meeting was led by William A. MacCrehan, QC engineer at Bendix Radio, Baltimore, Md. "Quality Control in Action" was the subject of his talk.

INDIANAPOLIS Lafayette Sub-Section Virgil Alexander, Chief Inspector, J. D. Adams Co., Indianapolis, presented a talk about applications of quality control at our Dec. 1 meeting. On Dec. 15, this sub-section was addressed by William E. Spencer, Allison Div., GMC. His subject was "Lot Plot and How To Make It."

KANSAS CITY The Dec. 8, meeting consisted of a dinner and plant tour in the BOP Div. of GM. Section members and friends toured both aircraft and automotive divisions.

LOS ANGELES Lt. Col. O. C. Griffith, San Bernadino Air Materiel Area, outlined the philosophy and aims of Specifications MIL-Q-5923B at the December meeting. A clinic was also conducted by Carl M. Boswell, Carl Boswell Assoc. on "What is SQC?"

LOUISVILLE On Dec. 13, the principal speaker for the meeting of the Louisville Section was W. J. Alexander who discussed the QC program at Reynolds Metals Co. It was evident from the talk that Reynolds is promoting the program intensively. The following day some 30 members of the section joined in a luncheon and tour of one of the Reynolds plants and an enlightening and enjoyable afternoon will long be remembered by those who attended.

Principal speaker at the Jan. 10 meeting was E. L. Faye, Deere and Co., whose discussion of "Tools of Quality Control" shed new light on the many possibilities of this specialized field.

MILWAUKEE The Milwaukee Section met for a plant tour and buffet supper at the Miller Brewing Co. A forum was held later concerning various phases of QC followed by a short film on QC and two on sports.

MINNESOTA Minneapolis Honeywell Regulator Co. was host to the members of the Minnesota Section on Wednesday, Dec. 8. The all day tour was conducted by the quality control personnel at Minneapolis Honeywell and planned specifically for individuals interested in quality control programs and to illustrate how the program functions in large plants.

The morning session started with an over-all view of quality control procedures and later small groups were conducted through the piece parts areas. At noon the members had lunch at a downtown cafe. Following the luncheon the groups were conducted on tours through the other Honeywell plants in the city. The tour was completed at the downtown plant where refreshments were served and final comments made pertaining to the overall quality control procedure.

The tour was exceptionally well planned and favorable comments were received from the large group in attendance.

MONTREAL On Dec. 2 the Engineering Institute of Canada were the hosts of a joint meeting between the EIC and the Montreal Section of ASQC. The event of the evening was a panel discussion on statistical quality control. The panel, all members of ASQC consisted of B. H. Lloyd, head of operations research, Leetham and Simpson Ltd., Montreal: P. E. Gnaedinger, director of quality control, Dominion Rubber Co., Montreal; L. C. Thompson, works manager, Canadian Industries (1954) Ltd., Brounsburg, Quebec; W. E. Patlee, technical superintendent, Consolidated Paper Co., Grand'mere, Quebec, and J. B. Pringee, staff engineer, Quality Analysis, Bell Telephone Co. of Canada, Montreal. The topics discussed by the panel included process quality control, acceptance sampling, special studies and management's viewpoint on statistical quality control. Judging from the lengthy discussion that followed the panel presentation, the engineers showed great interest in this new statistical technique.

NEW HAVEN On Dec. 7, 1954, the fourth dinner meeting of the 1954-55 season was held at the Colonial House, Hamden, Conn. Prof. R. E. Heiland, Lehigh University, our guest speaker, presented a very educational and interesting lecture on "Work Sampling," with particular reference to its use in office and maintenance work. The entire program was enjoyed by the good attendance.

ST. LOUIS The December meeting of the St. Louis Section was attended by one of the largest groups ever to attend a December meeting. There were better than 60 people present for the very fine presentation by Frank Caplan, "Electronic Experimentation." In his talk he outlined in detail the exacting work carried out by the General Electric Company in determining the best possible design of experiment to decrease cost and at the same time produce a better component. The meeting was followed by a rather interesting discussion and was certainly enjoyed by all who had the privilege of attending.

SCRANTON-WILKES-BARRE William H. Cook, Quality Control and Management Research Unit of the Bureau of Census, gave a most illuminating talk on statistical methods in management and the application of statistical quality control to office management.

SEATTLE J. J. Livers, Boeing Airplane Co., was the speaker at the Dec. 14 meeting of Seattle Section held in the Benjamin Franklin Hotel. His talk on "Measuring Association with Rank Valued Data" gave members a new viewpoint on methods of dealing with non-parametric data and the approximating of relationships with less mathematical manipulation.

SOUTHERN CONNECTICUT The December meeting of the Southern Connecticut Section was well attended and took place on Wednesday, Dec. 8. Guest speaker at the dinner meeting was Ephriam R. Freedman, Director, Macy's Bureau of Standards, who discussed "The Consumer Views Quality," from the viewpoint of the retailer. This meeting was unusual because its speaker is not an industrialist. In his job as head of the testing bureau of one of the world's largest retailers, Mr. Freedman explained the operation of his organization and its objective of consumer satisfaction. He pointed out that Macy's acts as buyers' agents for the public instead of distributors for the manufacturers. Quality specifications are determined by the customer through his decision to purchase or not to purchase goods.

SOUTHERN TIER The December meeting of the Southern Tier Section was held at the Vestal American Legion Clubhouse and was attended by 32 members and guests. The speaker was R. E. Bechhofer of Cornell University whose subject was "Designing Experiments for Ranking Means." Prof. Bechhofer's presentation was based in part upon the results of research being conducted for Naval Ordnance by Cornell University. The talk proved highly interesting to all present. This was attributed in great

measure to Prof. Bechhofer's very effective manner of delivery which was slanted toward the layman rather than toward the theorist. Copies of the talk were also given to everybody present.

STATE UNIVERSITY OF IOWA Robert Cannon, Eagle Signal Co., Moline, Ill. discussed some of the requirements for a successful statistical quality control application at the monthly meeting of the Quint City Group on Dec. 16. Mr. Cannon supplemented his interesting talk with a display of some of the traffic signals and timers manufactured by his company.

TENNESSEE
Chattanooga Sub-Section Members of the Chattanooga Sub-Section held a dinner meeting Jan. 4, 1955. A panel composed of R. S. Bingham, Jr., W. Whigham, H. Corwin, and L. J. Demorest discussed a paper entitled "Starting Points for Plant Quality Control."

The paper presented a hypothetical plant situation. It described an imaginary company, it's organization and products and outlined the methods of production and quality control. The problem of the plant was to meet competition by increasing quality and reducing costs.

Points emphasized following the presentation of the paper included the development of an organization and methods to prevent defects from happening; acceptance of products during the after fabrication; and assurance of quality. Of particular interest were some of the approaches to be used in reaching the goals of lower production costs, reduction of complaints and a sustained competitive quality level. Also emphasized was the need for stimulating quality consciousness and enlisting the aid of the individual worker in the overall quality control program.

TENNESSEE
Nashville Sub-Section On Tuesday, Dec. 7, Melvin Snow, Temco Corp., addressed the sub-section on the subject "Quality Control—An Overall Study of Case Histories." Following his speech was a question period which was entered into quite enthusiastically.

Shown above are Julien Green, guest speaker at the Dec. 8 meeting of the Toronto Section, Robert Cardno, Treasurer, and Marjorie Baskerville, Vice-Chairman of the section.

TORONTO In Hamilton on Dec. 8 Julien Green of Schenectady, N. Y., spoke on quality control in parts manufacture. The Master Control System as developed and applied by the Statistical Methods group at General Electric Co. was cleverly outlined. Pertinent information as presented to the manufacturing management is on one master sheet. The men who need to take action merely look on one sheet for circled out of control points and immediately go to their subordinates to question about details.

Furthermore, Mr. Green explained the Number Defective Table which was devised by his company. It eliminates computing of limits by manufacturing personnel. Instead the limits for an attribute characteristic can be found in a table by entering it with the percent defective representing past performance and the number of units inspected.

UNIVERSITY OF W. ONTARIO The executive committee held its first meeting of the new year at Brantford on Jan. 7. Plans were formulated with respect to holding a "What's Your Problem," and general "Get together," night of the Kitchener and London groups, to be held in Woodstock late in February.

A. Deacon, QC consultant of Brantford, gave a talk to the Kitchener Group on Dec. 1, his subject being, "Some Methods of Controlling Quality." The meeting was held at the Dominion Rubber Tire Factory.

W. MASSACHUSETTS There was no December meeting scheduled for this section. However, the Executive Committee met on Dec. 7 to complete plans for the year with special emphasis on the all day clinic to be held early in February on "Experimental Design."

WICHITA The Wichita Section was privileged to bring to this area an eminent authority on quality control in the person of Capt. Henry Simon, Chief, Quality Analysis Office at Headquarters Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio.

One hundred and one members and guests attended the dinner meeting held Tuesday, Dec. 7. Captain Simon held the unreserved attention of the group while he gave point by point the Air Force views of quality control. Captain Simon was introduced by Program Chairman Ed Sullivan, who also reported the progress made by the section in the Presidential Management Award Contest. Wichita Section Director, Ralph Humphries, reported and gave highlights of the Ninth Midwest Quality Control Conference.

WINNEBAGO On Dec. 6 the Winnebago Section held its monthly meeting at Art's Supper Club in Manitowoc, Wis. Speaker for the evening was Larry Meumann, Miller Brewing Co., whose subject was "Gaining Uniformity with SQC." A training session preceded the meeting.

WORCESTER As a "special event" our December meeting was held in a suburban area, Southbridge, for the purpose of promoting statistical quality control and to stimulate interest in the activities of the section as well as the National Organization. The facilities of the American Optical Co. in Southbridge were extended to the section for this meeting. The attendance was 121 and this included 25 members who came from as far as 40 miles away.

The speaker for the meeting was Charles W. Carter, Rath & Strong, and the title of his talk was, "Quality Mindedness."

As far as it can be ascertained, this is the first time that the Worcester Section has moved from its primary location for holding meetings to a suburban area 25

miles away, for the sole purpose of "bringing quality control" to the industries of Southbridge. Because of the success of this type of meeting, future plans will be formulated so that other areas may be visited and the "good" word regarding ASQC passed along.

YOUNGSTOWN C. G. Schelly, managing director of the Wilkie Foundation, addressed the Youngstown Section at a dinner meeting on Dec. 8, 1954 on "Civilization Through Tools." Five tons of equipment provided a very dramatic display of man's tools covering a span of a million years. A beautifully illustrated booklet was given to all attending the meeting.

"... CAST THEIR SHADOWS BEFORE"

ALLENTOWN-BETHLEHEM With A. G. Dalton of Western Electric Co. as the guest speaker and the naturally growing interest in QC incited by this section's excellent training program, we expect to "pack the house" at the Mar. 10 dinner meeting. The 7:00 o'clock dinner will follow a social hour at Hotel Traylor, Allentown, Pa. and the main talk by Mr. Dalton will start at 8 p.m. His topic will be "Quality Control from the Management Point of View."

CHICAGO The next meeting of the elementary educational series will deal with the construction and interpretation of p, np, and C charts. The speakers at this meeting will be Mae Godwin-Tarver, Continental Can Co., and Elenor Slifer, QC Consultant.

CLEVELAND Great plans are afoot by holding a "Quality Control Week" in Cleveland, Ohio, sponsored by the Cleveland Section. Arrangements are being made for a TV show and Conference. Times and dates will be announced as soon as arrangements have been completed.

DAYTON On Mar. 17 the regular technical meeting will be held at the National Cash Register Co. Auditorium. The Dayton Section will be host of this meeting to the Dayton Society of Professional Engineers and The American Society of Tool Engineers. The speaker for this occasion will be Brent C. Jacobs, Jr. of the Chrysler Corp., Detroit, Mich. The title of his subject will be "From Horse Sense to Electronic Brains."

EVANSVILLE-OWENSBORO J. L. Dolby, Product Engineer for Statistical Methods, General Electric Co., Schenectady, will "bring the message" to the Evansville-Owensboro Section at Dar-Nek Club near Owensboro, Ky.

INDIANAPOLIS On Mar. 19 the afternoon session of the Indianapolis Section monthly meeting will be led by Carl Hoover, Perfect Circle Corp. This meeting will be held in the World War Memorial Building at 4:30 p.m.

The evening meeting, starting at 7:30 p.m., will be addressed by Allen Woodell, Ternstedt Div., GMC, Detroit. The subject of his talk is "SQC Techniques as Applied to Purchased Steel." This meeting will be held at the Indiana State Board of Health Bldg. in the Rice Memorial Auditorium.

INDIANAPOLIS Richmond Sub-Section The meeting date for the February meeting of this sub-section will be Feb. 23. The speaker and subject will be announced later.

INDIANAPOLIS Columbus Sub-Section On Mar. 10 this sub-section will be addressed by Wm. E. Spencer, Allison Div., GMC. His subject will be "SQC Applications and Results."

KANSAS CITY The March meeting of the section will be held on Mar. 9. After the annual report of the nominating committee, there will be a tour of a local plant.

HARRISBURG On Feb. 2 Burr Stanton, General Electric Co., Erie, will address this section on "Selling Quality Control to the Factory." The meeting will be held at the Olmstead Air Force Base, Middletown, Pa. Dinner will be served at 6:30 p.m. with the meeting at 8:00 p.m.

MILWAUKEE The Feb. 21 meeting will be held at Marquette University, starting time being 7:30 p.m. Feature of the meeting will be a talk on "Selling Quality Control to the Executive," by William Spencer, Allison Div., GMC, Indianapolis, Ind. As an added inducement we will have free donuts and coffee after the meeting.

MINNESOTA On Thursday, Feb. 24 the regular meeting of the Minnesota Section will be held at the University of Minnesota. The speaker will be A. V. Feigenbaum, Manager of Quality Control and Cost Reduction for General Electric Co., Schenectady. The topic of his talk will be "Quality Control as a Management Method."

NEW HAVEN On Mar. 8 the seventh meeting of the 1954-55 season will be a dinner meeting held at the Colonial House, Hamden, Conn. featuring D. L. Lobsinger, of United Air Lines. Mr. Lobsinger's topic will be "Statistics and Customer Service."

RICHMOND "Statistical Applications to Time Study" is the subject of a talk to be given Feb. 22 by James R. Thomen, Statistical Research Engineer in the Film Division of E. I. duPont de Nemours and Co.

ST. LOUIS The February meeting of the St. Louis Section has always been an anniversary meeting at which time an officer of the National Organization has been present. This year Raymond S. Saddoris was to have been the speaker. The St. Louis Section has asked Paul K. Leatherman, an Executive Director of the Society, to present Ray's talk on the subject, "Key to a Better Way", and also to present to the local group some of the facts and pertinent data regarding the National Organization. We anticipate a rather large group at this meeting as a tribute to Ray Saddoris.

The Mar. 18 meeting will be a plant tour of the Granite City Steel Co., Granite City, Ill. It has been the practice of the St. Louis Section to incorporate a plant tour as one of their meetings during the fiscal year and this promises to be a very interesting meeting since the Granite City Steel Co. is one of the largest in the St. Louis area.

SALT LAKE CITY On Mar. 10 at a dinner meeting to be held at the University of Utah, a panel of members of this section will discuss "Quality Control Techniques Used in the Utah Area."

SCRANTON-WILKES-BARRE An exhibition, "Civilization Through Tools," will be given at the Scranton Chamber of Commerce Auditorium, Wednesday, Feb. 23, cosponsored by the Scranton-Wilkes-Barre Section and the Keystone Chapter of ASTE. The speaker of the evening will be C. G. Schelly, managing director of the Wilkie Foundation which with the Do-ALL-Co. is putting on the exhibit.

SEATTLE On Mar. 17, 18, 19 Seattle Section will be host to the 3rd Pacific Northwest Quality Control Conference, which will be combined with the 2nd Western Regional Conference. The conference, to be held in the Benjamin Franklin Hotel in downtown Seattle, is cosponsored by the University of Washington. A feature of the conference will be an institute in SQC principles which is to be held the first day at no extra charge to registrants. Prof. Berl Owens, Mechanical Engineering Dept., U. of Washington is Coordinator; Dr. J. J. Livers, Program Chairman.

SOUTH BEND-MISHAWAKA Feb. 17 is the date set for our social evening and promises to be one of the highlights of the season. The evening's entertainment will feature a dinner at one of the most popular restaurants in this area complete with a door prize for our ladies who will be our guests for the evening. The speaker's topic will be of special interest to our guests, not necessarily restricted to quality control.

Management night is scheduled for our Mar. 17 meeting, at which time top management from this area will hear a speech by E. L. Fay, Quality Control Adviser for Deere and Co. The meeting will be held as usual in the Engineering Auditorium of Notre Dame University.

SO. CONNECTICUT R. E. Wagenhals of the Timken Roller Bearing Co. will speak at the Mar. 9 meeting of the Southern Connecticut Section. Mr. Wagenhals has a wide background in industrial engineering and inspection. He will tell us how quality control functions in a bearing firm through his talk on "Quality Control At Timken." There are several bearing firms in this area whose members should find the meeting quite interesting. The meeting will be in the Stratfield Hotel, Bridgeport, at 8:00 p.m.

SOUTHERN TIER The Southern Tier Section will hold its monthly dinner meeting on Mar. 1, at the Vestal American Legion Clubhouse. The section will be privileged to have one of its own members, H. E. Stevens, Ansco Film Corp., as the speaker for the evening. Mr. Stevens' subject will be "Examples of SQC Applications in the Photographic Industry." Since the presentation pertains to one of the section's major industries, interest in Mr. Stevens' talk should be very high.

UNIVERSITY OF WESTERN ONTARIO Arrangements are well in hand for the visit of Carl Noble, who will be guest speaker at the dinner meeting to be held in Kitchener on Apr. 7. The subject of talk will be "Cost Control." As this is the first regular dinner meeting to be held in Kitchener, and taking into account the speaker and subject, a record turnout is expected.

WASHINGTON The subject for the Feb. 23 meeting is "Design of Experiments." A panel consisting of Charles A. Bicking, Office of Chief, Ordnance; W. J. Youden, National Bureau of Standards; and Besse B. Day, U. S. Naval Engineering Experiment Station; will discuss this subject and answer any questions from the floor. The meeting will be held at the National Canners Assoc. Bldg., 1133 20th St., N. W., Washington, D. C. The meeting will start at 8 p.m.

WESTERN MASSACHUSETTS The Mar. 1, 1955 meeting will feature W. R. Purcell of Rath & Strong, Inc. Mr. Purcell will speak on "Quality Control in Paper Industry." He will draw on his experiences in this field as an engineer and more recently as a consultant. His talk will be accented with demonstrating props.

WICHITA The March meeting of Wichita Section will be Mar. 1 and will bring to our section another in a series of outstanding speakers. D. L. Flanders, General Motors, Indianapolis, will speak on "Quality Control at the Allison Division."

YOUNGSTOWN On Mar. 10 the Youngstown Section has arranged for a dinner and plant tour of the Timken Roller Bearing Co., Canton. This promises to be an unusual and a very informative plant tour. The Timken plant makes considerable use of the many QC techniques.

"AS YE SOW . . ."

CLEVELAND The Cleveland Section has established pre-meeting discussions on its regular meeting nights. An able panel is available to discuss and advise on all problems which may be brought before it. Unlike the usual panel discussions, these pre-meeting bull sessions become the place of solution for many of the individual problems that confront many of us in the application of QC techniques. Our panel members have been able to help members in their individual problems which are frequently not covered in regular meetings where they feel they should not ask about personal problems. There has been an enthusiastic response to this type of discussion by members of the Cleveland Section.

The section is also holding its First Annual One-Day Quality Control Conference in Cleveland. The theme of this conference is "A New Look at Quality Control." It is the purpose of the conference to awaken those both in the field of quality control and in industry in general to the potentialities of quality control. Too many men in the field have not kept pace with more recent applications of new techniques, as well as making the best use of long standing practices.

The conference effort is directed at stimulating the thinking of these people, who, although they may be practicing quality control in a generally satisfactory manner, are not taking full advantage of the complete range of current quality control practices.

It is further the conference purpose to present a preview of things to come in the field of quality control and to stimulate the imagination of those in attendance so that they may be alert to applications heretofore not regarded as being in the field of quality control and as

CALENDAR OF MEETINGS — FEBRUARY 20, 1955 — MARCH 19, 1955

*Indicates meeting dates in February

SECTION	DATE	MEETING PLACE	TIME	SUBJECT	SPEAKER
Allentown-Bethlehem	10	Hotel Traylor	7:00 p.m.	Quality Control for the Management Point of View	A. G. Dalton, Western Electric Co.
Boston	15	M.I.T. Faculty Club	———	Introduction to the Span Plan	L. A. Seder, QC Consultant
Buffalo	28*	University of Buffalo	———	Tests of Significance in Industrial Processing	G. G. Parkin, Minnesota Mining & Mfg.
Cleveland	4	Cleveland Eng. Soc.	8:00 p.m.	Design of Experiments	B. B. Day, USN Engr. Exp. Sta.
Columbus	16	———	———	Quality Control Demonstrations	R. E. Wagenhals, Timken Roller Bearing Co.
Dayton	17	Nat'l Cash Register Auditorium	———	From Horse Sense to Electronic Brains	B. C. Jacobs, Jr., Chrysler Corp.
Delaware	3	———	———	SQC in the Office	G. J. Leahy, Sears, Roebuck & Co.
Evansville-Owensboro	15	———	7:15 p.m.	———	P. A. Robert, I.B.M. Corp.
Harrisburg	9	Inn 230, Middletown		Engineering Standards and Tolerances	E. E. Schiesel, Mattatuck Mfg. Corp.
Huntsville	16	———	———	Quality Control in Chemical Research	Carl Culverhouse
Indianapolis	15	Ind. State Board of Health Bldg.	7:30 p.m.	SQC Techniques As Applied To Purchased Steel	Allan Woodell, Ternstedt Div., GMC
Kansas City	9	———	8:00 p.m.	Annual Nomination of Officers; Plant Tour	———
Lansdale	10	———	———	Inspection by Optical Gaging Methods	Edward Polidor, Optical Gaging Prod., Inc.
Los Angeles	15	Rodger Young Auditorium	8:00 p.m.	Sampling Inspection by Variables	G. J. Lieberman, Stanford University
Michigan	18	Rackham Bldg., Detroit	———	Determination of Drug Potency in Man	C. I. Bliss, Conn. Agricultural Exp. Sta.
Mid-Hudson	1	———	7:00 p.m.	———	———
Milwaukee	21*	Marquette University	7:30 p.m.	Selling Quality Control to the Executive	W. E. Spencer, Allison Div., GMC
Minnesota	24*	University of Minnesota	———	Quality Control as a Management Method	A V. Feigenbaum, General Electric Co.
	17	———	———	Case Studies in Operations Research	R. L. Ackoff, Case Institute
New Haven	8	Colonial House, Hamden, Conn.	———	Statistics and Customer Service	D L. Lobsinger, United Airlines
NE Indiana	10	———	———	Application of QC in the Electrical Industry	W. J. Masser, General Electric Co.
Philadelphia	18	Franklin Institute	8:00 p.m.	Civilization Through Tools	The Do-ALL Co. & Wilkie Foundation
Rhode Island	17	———	———	Quality Control and Labor Standards	W. E. Biklen, American Safety Razor Co.
Richmond	22*	Holloway House	6:15 p.m.	Statistical Applications to Time Study	J. R. Thomen, E. I. duPont de Nemours
St. Louis	18	Granite City Steel Co.	8:00 p.m.	Plant Tour, Granite City, Ill.	———
Salt Lake City	10	University of Utah	———	Quality Control Techniques Used in the Utah Area	Panel
San Diego	14	Solar Auditorium	7:30 p.m.	Application of Quality Control to Metal Finishing	B. Swarts, Convair
Seattle	17, 18, 19	Benjamin Franklin Hotel		Pacific Northwest & Western Regional QC Conference	———
South Bend-Mishawaka	17	Notre Dame University	7:00 p.m.	Management Night	———
Southern Connecticut	9	Stratfield Hotel, Bridgeport	8:00 p.m.	Quality Control at Timken	R. E. Wagenhals, Timken Roller Bearing Co.
Syracuse	22*	———	———	A Study of Inspector Accuracy	H. J. Jacobson, Grand Sheet Metal Prod.
Toledo	17	———	———	Quality Control in the Milling Industry	P. O. Lysne, General Mills
Trenton	16	Hildebrecht Hotel	———	Civilization Through Tools—Joint meeting with SAM	The DoALL Co. & Wilkie Foundation
Washington	23*	Nat'l Canners Assoc. Bldg.	8:00 p.m.	Design of Experiments	Panel Discussion
W Massachusetts	1	Roger Smith Hotel, Holyoke	———	Quality Control in the Paper Industry	W. R. Purcell, Rath & Strong, Inc.
Wichita	1	———	———	Quality Control at the Allison Div.	D. F. Flanders, General Motors
Winnebago	7	Sheboygan	———	Foundry Quality Control	J. L. Barrabee, International Harvester Corp.
Worcester	17	———	———	Quality Control as a Management Method	A. V. Feigenbaum, General Electric Co.
Youngstown	10	Canton, Ohio	———	Timken Plant Tour	———

being amenable to treatment by quality control techniques.

The conference will take place on Mar. 29 at the Hotel Carter in Cleveland. Reservations may be made by contacting Mr. G. K. Montgomery, manager of quality control, Jack and Heinz, Inc., Cleveland 1, Ohio. The complete registration fee, including luncheon and banquet, is $17.50.

MILWAUKEE The initial planning committee meeting for the 10th Midwest QC Conference was held on Jan. 28 in Milwaukee. This is the first step in setting up the programs, budget, etc., for the next midwest conference to be held in Milwaukee in the fall.

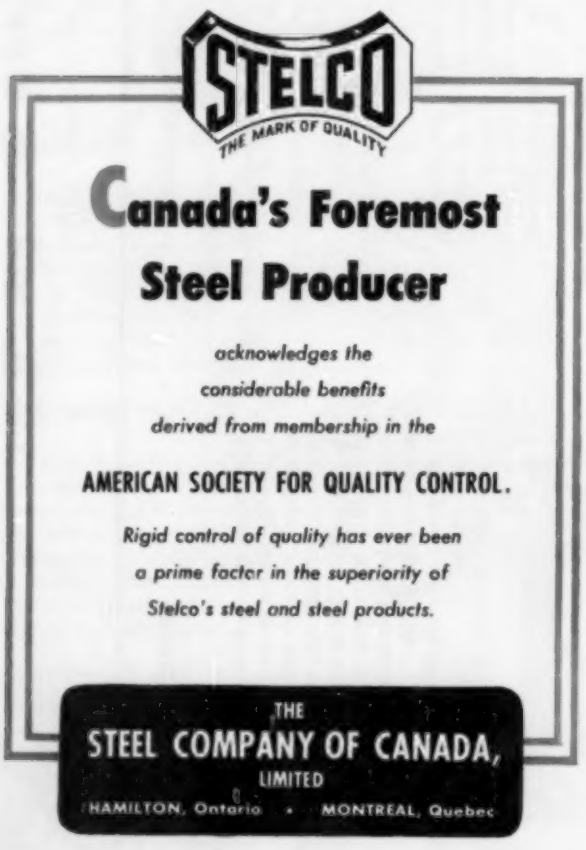
SOUTHERN CONNECTICUT Southern Connecticut members Bill Adam, Joe Von Dietsch and Sam Oliva will represent ASQC in this area during National Engineers' Week, Feb. 20 to 26. These men will speak before groups of high school seniors and explain the part quality control plays in industry. Discussions will take place principally in Bridgeport, Stratford, Fairfield and Stamford. On the afternoon of Feb. 26 an open house will take place at the University of Bridgeport where current engineering projects will be shown and latest engineering methods expounded. National Engineers' Week culminates on the evening of Feb. 26 with a dinner meeting in Bridgeport, with representative members of all the engineering societies participating.

WASHINGTON A basic QC course will be started on Feb. 20. The course will consist of ten 2-hour lectures and will be held once a week. The class meeting will be held at the National Canners Assoc. Bldg., 1133 20th St., N.W., Washington, D. C. The price is $10.00 for non-members and $5.00 for members. It will be a non-credit course. Lectures will be given by men prominent in the QC field.

WESTERN MASSACHUSETTS Jack Hinchen, our vice-chairman, and Lawrence Mueller, our educational chairman, are to teach a basic course in "Statistical Quality Control." This will be cosponsored by the Massachusetts University Extension and is to allow for college credit. This, in turn, means assignments will have to be made and examinations taken.

GEORGIA TECH A Statistical Quality Control Short Course will be conducted at the Georgia Institute of Technology, Mar. 7 through Mar. 15. This will be a basic course of intensive training to acquaint industrial personnel with techniques for putting SQC into operation. The staff for this course will include J. J. Moder, R. A. Hefner, and D. S. Holmes, Georgia Institute of Technology; and A. C. Cohen, University of Georgia.

For information write to Coordinator, Short Courses and Conferences, Georgia Institute of Technology, Atlanta, Ga.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"FOR MANY ARE CALLED, BUT FEW ARE . . ."

INDIANAPOLIS Lafayette Subsection The elected officers of the Lafayette Subsection for the 1954 55 year are: chairman—Prof. I. W. Burr, Purdue University; vice chairman—H. E. Wilson, Ross Gear and Tool Co.; Sec't'y-Treas.—W. B. Longren, Rostone Corp.

INDIANAPOLIS Richmond Sub-Section J. A. Harding, Belden Mfg. Co., has had to resign as Secretary-Treasurer for the Richmond Sub-Section. R. E. Kassen, Perfect Circle Sleeve Casting Plant, has temporarily accepted the office's responsibility until an election can be held.

SALT LAKE CITY Leon K. Nelson is the new Secretary of this section following the recent transfer of R. A. Cromer to the Denver operations of United Air Lines.

MEMBERSHIP CORNER

Indianapolis, the twenty-sixth city in the nation, has had one of the largest sections in the American Society for Quality Control since development of the following practices.

Membership is largely attracted by a training program. Four 20-hour courses are offered each semester and classes are held in a city high school building. Tuition is only $4.00 a course but membership in the Society is a condition. Text material is offered at cost or less. Instructors are selected with great care and paid the same scale as the high school evening school teachers. The school generally operates at a loss even though the section does not pay for use of the class rooms. Publicity

through the Chamber of Commerce in the form of letters to their manufacturing members brings in students and new ASQC members we are unable to attract through any other medium. These people may drive over 100 miles in an evening to attend our classes.

Membership is held to the Indianapolis Section by two means, attractive meetings and mutual aid of members. Many members gained to the Society by our school are not professional quality control men. They may be research people looking for statistical instruction, engineers, production people or inspectors. Our nine or ten meetings a year are arranged to maintain the interest of this group. We find the meetings should be inspirational rather than technical. Each person attending a meeting should go home resolved to extend either his knowledge or his efforts in behalf of quality control. The monthly meetings are preceded either by a late afternoon technical discussion or a "What Is Your Problem?" session. We find this often encourages members who must travel considerable distances to make the trip and a surprising number of members will turn out to get help or learn more about a specific technique if the meeting is well advertised in advance.

Mutual aid of members starts in the school. Students appeal to the instructor for help and get it. Later they will attend the "What Is Your Problem?" clinics. Mutual aid has progressed to even wider fields. One Indianapolis firm recently excused two people to leave their plant during working hours and give in-plant training to supervisors of another firm. The section promoted this since the appeal was made to the section by a member in behalf of his employer who had training time available during a slack period.

And last but not least it is Indianapolis' policy when possible to get local management to speak on the benefits of quality control. Such talks will be scheduled for a dinner meeting and get good publicity in local newspapers. They attract management attention and new members, but in the final analysis might also be classed as mutual aid, for many a quality control program has been firmed up after management has examined their own program closely enough to discuss it for thirty minutes.

SIGNIFICANT DIFFERENCES

Brent C. Jacob, chief industrial engineer of Chrysler Div. and member of the Michigan Section, spoke at the Nov. 17 meeting of the Society for the Advancement of Management. His subject was Pre-Control, which is a modern technique of the pilot plant equivalent to process control. In the event the basic process is incapable of holding a desired quality limit the method would quickly show the inadequacy.

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Miss Frances E. Hermann, treasurer of the Boston Section, has recently joined the staff of Arthur D. Little, Inc., industrial consulting and research firm of Cambridge, Mass. as a technical writer. A graduate of Radcliffe College in biochemistry, she took post-graduate work at the same college, participating in the management training program.

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The following item appeared in "Carrolls' Corner" of the South Bend Tribune, Nov. 17, 1954:

"Gent named R. C. Carrier writes to report that the ring around the moon and the cirrus cloud that formed a letter 'Q' over the South Bend-Mishawaka area last week was 'conjured up by the South Bend-Mishawaka Section of the American Society for Quality Control. The purpose of this display was to give publicity to our newly-formed section since Quality is our business.' Mr. Carrier did not report the method used by the section in getting the 'Q' into the sky. But if you see a press agent with wings and a halo in town, the mystery will be solved."

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Chairman of the Southern Connecticut Section, Sam Oliva, has appointed Ed Demers and Ed Dawes to a new committee. Their job will be to choose a "Man of the Year" candidate from the membership; a fellow from the group who has done the most for the section throughout the year's activities.

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State University of Iowa Section reports that Robert W. Boeke, one of the more active section members, recently accepted a position as quality control engineer with the John Deere Ottumwa works. Mr. Boeke, formerly associated with Deere in Moline, Ill. was a past chairman of the Quint-City group and program chairman of the section. At present, he is education chairman for the section, a member of the National ASQC Education Committee, and a member of the Section's Management Award Committee. Mr. Boeke, who holds a master's degree in statistics from Iowa State College, was also active in the preparation of the section's Quality Control Training Manual.

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Paul E. Allen chairman of the Wichita Section and director of quality control, Beech Aircraft Corp., was invited to address the SAE at their annual Utility Aircraft Meeting in Wichita, on Nov. 13. Mr. Allen spoke on "Simplified Inspection Techniques."

Also from Wichita comes this sage piece of advice:

"Is your 1954-55 Presidential Award Program lagging? Wichita Section decided to do something about their standing during the current year and dipped down into a bag of SQC tricks and came up with an incentive chart built around a horse race that has raised our standing tremendously."

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Irving Quart, publicity chairman of the Los Angeles Section, has recently been appointed general engineer with the Los Angeles Ordnance District.

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R. Hislap, who was previously with the Automotive Division of A. O. Smith Corp., Milwaukee, was recently appointed to the post of director of quality. Also at A. O. Smith, Milwaukee Section's membership chairman, Arthur Raeuber was appointed as director of reinforced plastic research.

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It is hoped that all members of ASQC who would like to become associated with the Brewing Industry Steering Committee will contact Donald F. Sager, Director of Quality Control for Anheuser-Busch Corp., St. Louis 18, Mo. Mr. Sager is attempting to get everyone interested in the Brewing Industry lined up so that it can at the earliest possible date become a new division in the Society's structure and growth.

Alfred E. Korn, membership chairman of the Southern Connecticut Section, recently moved to New Jersey with his family. Replacing Mr. Korn as the new membership chairman will be Stuart K. Lyle, Jr., QC engineer at the Bridgeport Works of General Electric Co.

Edward Demers was appointed as chairman of Southern Connecticut's Section Development Committee, an idea proposed early in 1954. Other committee members are Howard Parsons, Anthony D'Apice, Nicholas Parahus, Stuart Lyle and Guy Boyd. The first major job which the committee is currently working on is compiling lists of employees in companies where the section does not now have any members.

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Congratulations are still being received by western Ontario's chairman, J. George, on the success of the "Management Panel" meeting held in Brantford last November. Here, five general managers formed the panel, and gave their views on quality control. The interest shown can be gaged by the fact that there were 72 paid attendances, and never was there a shortage of questions to the panel.

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Dr. Amihud Kramer, on a year's leave of absence from the University of Maryland, is with an F.O.A. mission to Israel. He is food processing advisor stationed at Tel-Aviv.

Jerry King, Bureau of Ordnance, just came back from an extensive European trip where he saw quality control in action under the American off-shore procurement plan. In his travels he found MIL-STD 105A printed in French and Italian.

Edwin F. Abrams, formerly a research and development chemist with Atlantic Research, is now a physical chemist with the Naval Ordnance Laboratories, White Oaks, Md.

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An unusual part of Wichita Section is the membership from the Continental Can Co. of Coffeyville, Kans. Continental Can has 14 active members in the Wichita Section. The unusual part is the fact that Coffeyville is approximately 150 miles southeast of Wichita, and that constitutes a long drive to attend the different functions of the Section. Notwithstanding this fact, the membership from Coffeyville is very active, very faithful, and we are proud to have them.

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On Oct. 18, William S. Hansen, a new member of the Milwaukee Section succumbed to heart attack at the age of forty-three. He was employed as chief industrial engineer at the Durant Mfg. Co.

The death of Henry J. Schwarz, Jr., on Jan. 13, was regretfully announced by the Cincinnati Section. He was Vice-Chairman and Program Chairman of the section and held the position of Quality Control Manager for the Clopay Corp., Cincinnati, Ohio.

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NEWS FROM PAUL CLIFFORD

Here is part of a letter received in the Editorial Office recently from Paul Clifford. It gives an interesting insight into the project in which he is engaged, and should be of interest to many of our readers.

Trondeim, Norway
November 19, 1954

Dear Mason:

This is a lot of fun, trying to do myself what we did in India. The program as I worked it out is this: Visit a country for two weeks, giving pep talks, visiting plants, and holding meetings with those interested in SQC to arouse interest in a training program. Come back a month or two later to conduct a training program for eight days. Do this with the help of the best person you can find. Return again two months after this for a follow up conference with the individuals in the training program, where they will present reports on the particular problems they worked on in their own plants, and I will criticize and suggest. Quite a job and a very interesting but tiring one.

We have just finished the first such training program here in Norway and I am lucky. I managed to get the OEEC to hire Hald for counterpart, and he is wonderful. After we returned from India Hald started training people in Denmark—by this spring he will have trained 300. He took all the ideas we had in India, improved the ones he liked, and turned out a set of notes that unfortunately I cannot read but that are excellent. Moreover, he has a set of reports from these students on actual projects that are the best I have ever seen. Makes me feel like a sluggard in comparison. And he is as pleasant to work with as ever. This is the last day. Hald is covering the Mil Std, while I get ready to take over on Dodge-Romig.

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ON THE IMPORTANCE OF RELIABLE DATA

The following anecdote was submitted by W. L. Gillette, Quality Control Engineer at the Allentown Plant of the Western Electric Company in Allentown, Pennsylvania. It came to the attention of Mr. Gillette under the title of "A Popping Good Gag," which appears on p. 84 of "Laughing on the Inside," and is reprinted here by permission of Dell Publishing Company, Inc., publishers of Dell Book, "Laughing on the Inside."

A man sought medical aid because he had popped eyes and a ringing in his ears. A doctor looked him over and suggested removal of his tonsils.

The operation resulted in no improvement, so the patient consulted another doctor who suggested removal of his teeth. The teeth were extracted but still the man's eyes popped and the ringing in his ears continued.

A third doctor told him bluntly, "You've got 6 months to live." In that event, the doomed man decided he'd treat himself right while he could.

He bought a flashy car, hired a chauffeur, had the best tailor in town make him twenty suits, and decided even his shirts would be made to order.

"Okay," said the shirtmaker, "let's get your measurements. Hmmm, 34 sleeve, 16 collar—"

"Fifteen," the man said.

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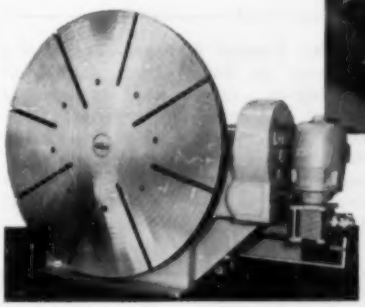

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"Sixteen collar," the shirtmaker repeated.

"But I've always worn a 15 collar," said the man.

"Listen," the shirtmaker said, "I'm warning you. You keep on wearing a 15 collar and your eyes will pop and you'll have a ringing in your ears."

REPORT OF NOMINATING COMMITTEE

In accordance with the provision of the Constitution of the Society, the Nominating Committee for 1955 herewith reports the following unanimously chosen nominees for the Society officers in 1955-56.

President:
Arthur Bender, Jr.
Delco-Remy Division GMC
Indianapolis Section

Vice-Presidents:
Leon Bass
General Electric Company
Cincinnati Section
Dale L. Lobsinger
United Airlines
Denver Section
Dorian Shainin
Rath and Strong, Inc.
Hartford Section
Julian H. Toulouse
Owens Illinois Glass Company
Toledo Section

Executive Secretary:
C. E. Fisher
Bell Telephone Laboratories, Inc.
Metropolitan Section

Treasurer:
Ervin E. Schiesel
Mattatuck Manufacturing Co.
Southern Connecticut Section

Each of the above nominees has expressed his willingness to accept if elected to the office for which he has been nominated.

POSITIONS WANTED

Address all replies to box number references to: American Society for Quality Control Room 563, 50 Church Street, New York 7, N. Y.

Young (26) experienced SQC analyst and supervisor with heavy math and statistical background plus some grad work desires position with company with genuine SQC program. ASQC member. Draft exempt. Please reply to Box 11H1 at the above address.

QUALITY CONTROL MANAGER
Quality Control Engineer with three years experience in applying SQC through all phases of development, production and inspection; including preparation of procedures and in plant training programs. Successful record as organizer and administrator. Please reply to Box 11H3 at the above address.

QUALITY MANAGER
"Mature, experienced quality manager desires responsible position directing inspection or quality control function. Fifteen years experience of high level responsibility for organizing and directing inspection and quality control departments. Successful in applying SQC to industrial problems. Many years of direct contact with Armed Service Inspection agencies." Please reply to Box 11H2 at the above address.

POSITIONS AVAILABLE

Address all replies to box number references to: American Society for Quality Control Room 563, 50 Church Street, New York 7, N. Y.

Quality Control Manager—Progressive company in Southeastern states has opening for a man to head up a quality control and inspection program. Ordnance projects and metal fabrication. Send resume with education and professional background including salary requirements. Please reply to Box 11V1 at the above address.

Mathematician - Statistician

Challenging position at our Baton Rouge location heading up program on computer applications to chemical research, engineering and manufacturing problems. Will also serve as expert on statistical design of research and development experimental programs, and the general application of mathematical techniques and models.

Applicant should have strong engineering or physical science background and familiarity with digital computer programming. Advanced degree (or equivalent experience) in (1) mathematics or statistics, or (2) engineering or physical science is required. Ability to cooperate in a team approach to problems is essential.

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